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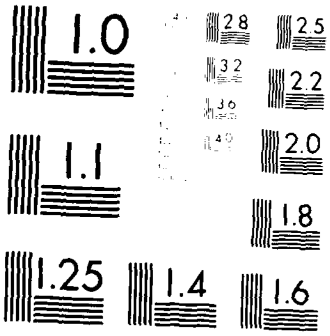

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DEPLOY:
An Interactive
Goal Programming Model
for the
Rapid Deployment of Armed Forces

THESIS

David C. Tate
Captain USAF

AFIT/GOR/OS/84D-14

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DEPLOY is an interactive Goal Programming Model for the Rapid Deployment of Armed Forces which offers decisive advantages over any current methodology. The front-end user-friendly package allows the user to easily enter the necessary data either interactively or via external files. Furthermore, data files can be easily created and altered to perform sensitivity analysis on any of the parameters in the model.

DEPLOY accounts for both intertheater and intratheater airlift, and can be used to optimally plan movement schedules for predetermined forces or optimally choose and move a force from a list of available units and airlift resources to meet specified goals. In addition, further analysis can be performed to determine the least number of aircraft or the least costly aircraft inventory necessary to accomplish the specified goals.

This report describes the physical and mathematical, scenario limitations, and input requirements of DEPLOY. Further, the report includes a user guide, variable definitions, subroutine definitions, and computer listings. The scenario used to demonstrate DEPLOY used 188 decision variables and 126 separate equations. Finally, this demonstration serves as an example to any potential users of DEPLOY.

AFIT/GOR/OS/84D-14

DEPLOY

An Interactive Goal Programming Model For the Rapid Deployment of Armed Forces

THESIS

Presented to the Faculty of the School of Engineering

of the Air Force Institute of Technology

Air University

In Partial Fulfilment of the

Requirements for the Degree of

Master of Science

by: David O. Tate

Captain USAF

Graduate Operations Research

December 1984

Approved for public release; distribution unlimited

Preface

DEPLOY is an interactive Goal Programming Model for the rapid deployment of armed forces. The project was suggested by LTC. Ivy D. Cook as a continuation of Captian James Cooke's thesis.

Special thanks go to my thesis advisor LTC. Cook who not only gave me a wide latitude to work independently, but also gave many pertinent suggestions along the way. I am also grateful to Major James K. Feldman, my reader, whose words of encouragement always came at the right time.

Furthermore, I am especially indebted to my wife, Linda, and son, Bryan, whose love and needed distractions helped me keep my perspective and enjoy life in the midst of this overwhelming project.

Finally, I acknowledge my Lord and Savior, Jesus Christ, for giving me the true meaning and perspective of life. This is best stated up in Psalms 73:25 which says, "Whom have I in heaven but Thee? And besides Thee, I desire nothing on earth."

David C. Tate

Contents

List of Tables

ABSTRACT

DEPLOY is an interactive Goal Programming Model for the Rapid Deployment of Armed Forces which offers decisive advantages over any current methodology. The front-end user-friendly package allows the user to easily enter the necessary data either interactively or via external files. Furthermore, data files can be easily created and altered to perform sensitivity analysis on any of the parameters in the model.

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DEPLOY

An Interactive

Goal Programming Model

for the

Rapid Deployment of Armed Forces

I. Introduction

In 1984 Army Captain James Cooke, an AFIT/GST student, demonstrated for the first time a particular methodology which determines how the interactions of unit weight, combat attributes, logistics needs, and airlift resources can be jointly optimized.(7,4) In his thesis he determined analytically the optimal force mix or the incremental advantage in deployed power attainable by an incremental change in airlift resources. The thesis DEPLOY was developed in response to recommendations in Cooke's thesis "Optimizing Force Development and Force Structure for the Rapid Deployment Force." (7:ff) The thesis by Cooke originated from "a perceived need to approach the deployment of combat forces using a total systems methodology, rather than the present method of separate mission/service optimization studies." (7:1) The model developed here takes the methodology demonstrated by Cooke and expands it to an interactive user-friendly computer program. Furthermore, this model allows the user to "generate unit movement and force structure requirements for the Rapid Deployment Force." (7:132) A background section is included in this chapter to inform the reader of the perceived need for a project like DEPLOY. Also included are sections on the Research Scope and Methodology. (7:4-8)

Background

In 1980, The United States government indicated a need for the capability to move large conventional ground forces to any location within a broad geographic area centered on Southwest Asia. As a result of this requirement, the Rapid Deployment Joint Task Force (RDJTF), now redesignated the Central Command (CENTCOM), was formed. This force consists of the 82nd Airborne Division, the 101st Airborne Division (Airmobile), the 24th Infantry Division, two Ranger battalions, and Air Force, Navy and Marine forces. The RDJTF Army units are all forces which facilitate air transportability.

Although CENTCOM was developed in direct response to a perceived threat, the Air Force has insufficient aircraft resources to support the full and rapid deployment of CENTCOM assets. The Army, in its deployment planning, can consider only the inventory of the Military Airlift Command (MAC) assets. When planning a deployment, therefore, critical decisions must be made as to how best to use limited air transportation. The basic decision is to increase the combat potential available to the ground commanders at the risk of reducing sustainability of the already deployed force. Combat potential is a complex and currently subjective index of the fighting capabilities of the force. These capabilities are based on deployed troops, tanks, and artillery. Sustainability is thought of as the continued ability of a force to fight through maintenance of in the event its supply line.

The Army must plan the deployment of its troops in such a

way as to balance combat potential with sustainability. Currently, scenario war plans are developed by operations analysts, who determine what forces they believe are required and by what date the forces are needed for a given scenario. Logisticians then calculate required supplies to support the force, using tabulated data. Given this data, the transportation officers attempt to move the required force packages by the required dates. If this is deemed impossible, the force planners either extend the required due dates or reduce the planned force.

The implementation of this process is a result of Under Secretary of Defense Chayes' report requiring between 50 and 150 C-5A equivalents in airlift to meet urgent national security needs. (3:30) Limited airlift assets prevent the Army from moving all cargo and troops required at a single time to respond to a major threat. Therefore, decision makers must be able to evaluate, at each point in time, how best to use the forces and resources available. This could be done by incorporating into the process the reduction of airlift resources caused by each force unit's "tail", the logistical requirements of the force.

Although this is a critical consideration for U.S. planners, research to date has addressed the problem only peripherally. The U.S. Army War College 1983 list of "strategic issues...most relevant and urgent for the Army to study" specifically identifies the issue of sustainability and mobility as an unsolved research area. Col. Daley, Chief of the War College Military Operations and Planning Group; LTC. Murphy, Air Force Liaison to the Doctrine and Force Issues Group of the War College Military Strategy department; and Mr. J.E. Trinnamen, head of

There are model limitations and time requirements that are important when using RAPIDISM. All significant limitations in the model are computer dependent; therefore, given a computer with enough core, limitations are reduced to nil. The time considerations will be discussed now. After requiring approximately two weeks to acquire the data base, another one week to two man-months are necessary to structure the data into the proper format. The computer time is about 1 minute per model cycle and the model requires four hours to two man-days to analyze and evaluate the output.

J. RECEIVER ONE

RECEIVER ONE was developed and is used by HQ USAF/SAGM five times a week. This model analyzes the problem of "airfield saturation during force deployment ." Each aircraft in the model is considered from the approach to landing until the takeoff departure. Included also in the model are the possible effects of weather, interdiction, and air base losses. There are basically three input parameters for RECEIVER ONE.

1. Base characteristics, such as parking space and amount of material handling equipment (MHE)
2. Aircraft characteristics, such as aircraft payload
3. Average expected arrivals of each type aircraft at each destination APOD (may change daily).

The output information is as follows:

1. Computer printouts on utilization of APOD facilities
2. Queueing delays at various stages of base processing
3. Aircraft elapsed times
4. Tons delivered
5. Tons diverted from the primary APOD.

The model can examine up to seven different APOD's and twenty

level of deployment activities, and basing and readiness levels of resources." (33:515)

There are limitations to this model and time requirements that must also be considered. Some limitations are that the vehicles are fractionalized and all events in the model are deterministic. Also, the cargo requirement integrity is not maintained in the model. This model requires two weeks to acquire the data base, and one week to two man-months to structure the data into the proper format, about 40 minutes to an hour of CPU time is required, and four hours to two man-days are necessary to analyze and evaluate the results.

I. Rapid Intertheater Deployment Simulator (RAPIDISM)

RAPIDISM is used by the JCS (J-4) approximately 260 times a year and was developed by the General Research Corporation. This model simulates the rapid deployment of combat units along with the resupply of these units for a military contingency operation. By using this model, the minimum time to deliver the units to these destinations via the air or the sea is determined. Different priorities can be assigned to the units and supplies. The model is deterministic in nature. The input parameters of the model are as follows:

1. Available number of aircraft by class
2. Available number of ships by class
3. APOEs, convoy route, and APODs
4. Transportation modes
5. Time periods for initial ship availability
6. Commodities and units
7. Attrition rate of vehicles (33:539)

As a result of this input, a detailed log of movements and numerous summary reports are produced.

3. Specified locations are aggregated into notational locations
4. Aircrew resources are not addressed
5. Tanker aircraft are assumed available by the model. (33:423)

This model requires only three man-hours to structure the input format. Then after about 30 minutes of CPU time per 90-day war scenario, 6 man-hours are necessary to analyze and evaluate the results.

H. POSTURE System

POSTURE is used by the JCS (J-4) approximately five times a year and was developed by the General Research Corporation. This model determines "the strategic mobility resources required for contingency situations and assesses the delivery capability of a given set of resources." The model accomplishes this by discovering the least-cost system to meet the stated requirements. Further, the model can determine the maximum deployment capability of a given set of mobility resources. In order to accomplish this, linear programming is utilized. The model utilizes land, air and sea mobility resources. The input parameters are as follows:

1. Origin/destination sets for force transfers
2. List resources
3. Cost parameters for the resources
4. Time-phased requirements by contingency and unit type
5. Vehicle characteristics, speed, payload
6. Allowable routes and route distances
7. Operational delay assumptions
8. Attrition factors (if used)
9. Convoy limits by theater and time period
10. Resource availability
11. Cargo characteristics.

The result of this input is a "10-year system cost, fleet sizes,

G. MACRO Model 12

The MACRO Model 12 is used by MAC Headquarters and was developed by the MACRO Task Force. The model measures "the total delivery performance of the MAC system reflecting the effects of aircraft queueing." Other effects that are considered are: station denial, air refueling, alternate routing, various fleet mixes, and limited ground support. The model is stochastic in nature and uses Q-GERT simulation language as the primary solution technique. The input requirements are divided into four different areas as follows:

1. Applied aircraft (number and type)
2. Initial aircraft availability schedule
3. Cargo requirements (from-to by cargo class)
4. Current configuration of wartime scenario (if different from the present configuration).

From this input the model gives the following output:

1. Flying hour requirements
2. Aircraft UTE rates
3. Route usage by leg segment
4. Aircraft waiting times
5. Movement closure time
6. Closure by cargo class and aircraft type
7. Delivery rate by cargo class
8. Location work load
9. Number of aircraft queueing by location
10. Aircraft handling requirements
11. Ground time histograms
12. System onload/offload history
13. Periodic reports reflecting aircraft and cargo status by location or various time intervals
14. Standard Q-GERT output including trace options
15. Designed user-specified output as desired. (33:423)

There are model limitations and time requirements that must be considered in using the MACRO-12 model. There are five major limitations to the model as follows:

1. All cargo is measured in terms of aircraft loads
2. The routing algorithm is completely probabilistic

F. Military Airlift Capability Estimator (MACE)

The Military Airlift Capability Estimator (MACE) is used by the JCS (J-4) and was developed by MAC. The model assists the transportation planner to quickly estimate the force closure times for the airlift of large-scale troop and cargo movements. The model is used about 75 times a year. The input parameters are three-fold; force definitions, aircraft ground time, and different requirements such as the distance between the APOD and Aerial Port of Embarkation (APOE). As a result of this input, the following output is given:

1. Schedule of the daily movement capability of the aircraft employed
2. Closure times at the destination of the force being moved
3. Individual requirement tracers
4. Aircraft mission traces
5. Aircraft utilization summaries
6. Requirement closure summaries. (33:412)

There are limitations and time requirement problems that are associated with the use of the MACE model. The first of the three limitations is that airlift is the only mode of transportation considered. Second, "aircraft can be prepositioned for the first acquirement only," after this, the aircraft are just positioned where needed. Third, the "time-phased processing of requirements" is not considered. Also, there are several time factors to be considered. After acquiring the data base which takes 1 man-month, 1-1/2 man-weeks are required to structure the data into the model input format. Then, after approximately 30 minutes of CPU time, 1-1/2 man-weeks are needed to analyze and evaluate the results. (33:412)

has three basic input parameters to the model.

1. Sorties required to move a given unit by different aircraft types
2. The number and Utilization (UTE) rate of each type of aircraft
3. The flight time for a round trip.

As a result of this input, the model gives the transportation completion times of the different cargo types and of the entire project. The model can utilize a maximum of six different aircraft types, only three of which can be capable of handling outsize cargo. (33:229)

E. M-14 (Model 14)

Model 14 was developed and is used by HQ MAC/XPSR about once a month. The model identifies and helps resolve the "strategic aircraft chokepoints at the airbase level during wartime surge situations." The model is a computer simulation of the MAC system involving four types of aircraft and 422 airbases. The aircraft are heuristically "routed to use idle resources and to avoid facility and personnel saturation." There are two main input parameters.

1. Station data, e.g., location, resources, climatology
2. Aircraft operating envelopes as movement requirements and policies.

The output generated is the raw form of "mission itineraries, requirement histories, GASP statistics, queueing files, and other simulation information." From the examination of this output many different types of studies can be performed. This model requires approximately two man-weeks to acquire the data base and to sequence the data into the proper format. Finally, one man-week is required to analyze the data. (33:412)

analysis time are variable with the size of the problem.

C. Air Movement Planning System (AMPS)

The Air Movement Planning System (AMPS) is used and was developed by the US Army Logistic Center. This model optimizes a given load plan to determine its feasibility. It is accomplished by planning, diagramming and manifesting individual "aircraft loads of equipment and personnel for movement on C-5, C-141, and C-130 aircraft." (33:43) To optimize the load plan, specific characteristic, balance and safety constraints are considered. There are two input parameters into the model, the cargo and aircraft list. The output is a schematic of the load plan and a manifest of the cargo and passengers.

There are limitations and time requirements that are associated with the AMPS model. The first limitation is that the cargo is considered as cubes with a certain weight and center of gravity, rather than as a specific piece of cargo. As a result of this limitation, such characteristics as axle location and vehicle overhang are not considered. The second limitation is that the "vehicle tie-down space is determined on the worst case basis rather than specifics." (33:43) When considering the time requirements for this model, one man-month is required to prepare the data base for the input parameters. Further, once the input is made, one hour of CPU time is needed to determine the output.

D. DELIVER

The DELIVER model was developed and is used by HQ USAF/SAGM about 250 times a month. The model estimates "the time to deliver a given military force by airlift [by providing] computerized analysis of sortie output from the ALM." The model

aircraft." This model is further used not only to evaluate current and future aircraft designs but also to determine the effect of changes in military vehicles. The model "determines the number of sorties required to load a military force of any size." The input parameters are in the form of three input files: vehicle characteristics, unit description, and an overall input file. These files are further described as follows:

1. Vehicle characteristics are dimensions and weight.
2. Unit descriptions include the number of personnel, weight of unit equipment, and the number of each type of vehicle.
3. The overall input file includes aircraft descriptions, unit accompanying supply formulae, aircraft loading sequences, selections of units, and input and output options.

The output of this model can give a multitude of information, including individual loads and "distribution of loads by weight and aircraft type." Furthermore, the loadability of vehicles is given along with "unit and overall summaries of payload and sortie statistics."(33:37)

The ALM is very versatile as it can use a multitude of different input parameters. The model is limited to considering 10 different aircraft types, 999 vehicle types, and 1,000 units. Each aircraft cargo compartment can be divided into ten different sections, and "up to ten groups of vehicles can be limited or excluded from an aircraft."(33:37) Furthermore, one type of special load can be forced into any aircraft per load.

The time requirements to use the ALM are variable. The CPU time to run the model on a Mechanized Brigade requires approximately 45 seconds. Both the preparation and the output

As a result of this input, the model gives a "statement of loadings of each aircraft by chalk number, consisting of a detailed listing of each 'loaded' aircraft." Also, a summary is given that yields the following specific output:

1. Number of sorties required
2. Cargo and passengers not loaded (i.e. those things that are too large, too heavy, or passengers for whom there are no seats on the aircraft)
3. Number, weight, and floor space of vehicles and bulk cargo loaded
4. Number of passengers loaded
5. Total fleet weight, floor space, and passenger seats that were available for loading. (33:29)

There are two major limitations to this model. First, the "sortie generation" technique does not necessarily give the optimal loading plan. As a result, the number of sorties required for the mission is not necessarily a minimum estimate. Second, the possibility of using a mixed type of fleet is not available as only one type of aircraft is considered.

When using this model there are a few time requirements to be considered. Approximately one month is required to acquire the data base for the input. Once the data base is finished, very little, if any, work must be done to format the data base for the input. Once inputted, approximately 10 minutes of CPU time per model is required to compute the output. Finally, it takes one man-day to analyze and evaluate the output.

B. Aircraft Loading Model (ALM)

The Aircraft Loading Model (ALM) is used and was developed by USAF/SAGM. Furthermore, the model is used about 100 times per month. The purpose of the model is to "provide computerized analysis of the loadability of military vehicles on airlift

II. Literature Review

This chapter will review the different strategic deployment models that are presently being used in the military. Several models will be discussed, but the central theme is the movement of personnel and cargo via airlift. The user and the developer of the model will be discussed first, followed by the purpose and description of the model. Then the input parameters will be examined along with the output statements. Finally, the model limitations and time requirements of the model will be considered.

A. Aircraft Loader Model

The Aircraft Loader Model is used by the JCS (J-4) and was developed by the Institute of Defense Analysis (DIA). The purpose of the model is to estimate "the number of airlift aircraft required to perform a stated transport mission." To accomplish this purpose, the model simulates loading the aircraft. Further, this model can be used to plan operations, compare aircraft sorties required for different aircraft types, and study alternative loading configurations. Numerical analysis is used to solve the mathematics of the model. This model is used approximately ten times per year. Some of the input parameters of the model are as follows:

1. Weight allowable cabin load (WACL) for the aircraft type and range of operation
2. Dimensions of the cargo compartment
3. Number of passenger seats available
4. Allowable stacking height for the bulk cargo
5. A complete vehicle and bulk cargo list with their dimensions
6. The number of passengers and their total weight.

models. In each model the input and output parameters will be examined. Finally, prevailing assumptions and approaches of the different models will be addressed.

Chapter III will present the mathematical formulation of the model utilizing the work of Capt Cooke as much as possible. This will include the formulation of the goals and constraints.

Chapter IV will review goal programming and present a description of the assignment algorithm, PAGP.

Chapter V will present some characteristics of DEPLOY. This will include model restrictions, scenario limitations, and input requirements. Chapter VI will provide both a verification and a demonstration of DEPLOY.

Chapter VII will present a summary of the modeling process, a description of the uses of DEPLOY, and a discussion of the potential improvements of the model.

variance from them is allowable but undesirable, are the following:

1. Keep a certain fixed or minimum ratio between combat and combat support units.

2. Keep unit sustainability, as reflected by percentage of required supplies delivered, at a fixed level.

3. Maximize the anti-tank strength, defensive frontage or combat power of the deployed force.

4. Maximize utilization of the Air Force airlift assets, in tonnage and allowable cubage.

5. There is a limit on the number of each type of aircraft available.

Constraints which are absolute are the following:

1. Outsize cargo will fit only outsize capable aircraft. Oversize cargo will fit on outsize aircraft or on oversize capable aircraft. Bulk cargo will fit on all cargo-carrying aircraft.

2. A deployed unit consumes supplies at a fixed rate over the entire period of analysis.

3. All aircraft types are capable of landing at the Aerial Port of Debarkation (APOD).

4. Unit sustainability has a floor. United States National Command Authority will not build up force strength at the expense of letting troops already deployed run out of ammunition or food.

5. Supplies delivered to the APOD must be trucked or airlifted to the combat forces at the front.

Format Structure

Chapter II will review many of the currently used deployment

address only air-deployed and air-supported units. The close presence, in a crisis, of logistics ships or Marine Amphibious units is fortuitous, but cannot be relied upon with worldwide commitments.

2. Once deployed into the theater, the standard supply consumption rates will be used.

3. This study will incorporate any type of military or Civilian Reserve Air Fleet (CRAF) aircraft to move CENTCOM assets.

4. Sustainability will be kept as a constant measure across the entire deployed force. That is, all forces, if unsupplied, would run out of all supplies at the same time. This is assumed as a logical result of proper logistical planning, as it would not be acceptable, in combat, to run out of ammunition but to have ten days of food available.

5. The input data file may either already exist, be created interactively, or be changed interactively and saved if necessary for later use.

Research Methodology

The overall objective of this study is to develop DEPLOY, a user-friendly computer program to maximize combat power delivered to a theater as a function of time without diminishing a certain sustainability of the forces already deployed. This problem is broken into two subordinate and equally important goals: maximize the combat power delivered, and minimize the delivery time. These goals are optimized only after certain constraints are satisfied. Constraints which can be expressed as goals, because

Mediterranean Studies for the Strategic Studies Institute, have all separately proposed that immediate research be conducted on this topic. (7,18-26)

Problem Statement

The methodology demonstrated by Capt Cooke exists in mathematical form, and is therefore not immediately helpful to the user. There is no interactive user-friendly computer program that performs the kind of analysis demonstrated by Capt Cooke.

Research Objective

The primary objective of this research effort is to develop an interactive user-friendly computer program to optimize combat power delivered to a theater during a specified time, within acceptable levels of force sustainability. The methodology demonstrated by Capt Cooke will be examined concerning its completeness and extended from its mathematical form to an interactive computer program. This program will be composed of two parts, the construction of constraints and the allocation of deployed units with aircraft. The information necessary to build the goals and constraints will be input in such a way that the user can easily change parameters and goals as desired. The allocation routine, PAGP, will minimize the deviations from the user-defined goals. Here, the objective measure of merit simultaneously incorporates unit weights, requirements, combat power attributes, and in-theater constraints to find the global optimal solution.

Research Scope

1. With the emphasis on rapid deployment, this study will

different aircraft types. In order to create a senerio, eight to ten man-hours are needed, while only one hour is needed for moderate changes in the senerio. Once the model is complete, only one to two hours is needed to analyze the output. (33:555)

K. Simulation for Transportation Analysis and Planning (SITAP)

The SITAP model is used by the JCS (J-4) about 50 times a year and was developed by the Computer Sciences Corporation (CSC). This model analyzes a wide spectrum of transportation vehicles and uses a network system to complete the analysis. The "different movement demands, vehicles, and defined network are controlled by the analyst." The input parameters are as follows:

1. The network design
2. Vehicle characteristics and movement
3. Cargo description and quantities.

As a result of this input the following output is given:

1. Mean response times between cargo ordering and delivery
2. Cargo and vehicle throughput
3. Resource, manpower, and facility utilization
4. Vehicle waiting times, service times, and idle times for each vehicle type node.

All the limitations of the model are directly related to the size of the computer. In order to adequately use the model, one to two man-weeks are required to acquire the data base, after which another man-week is needed to format the data. After the computer run is made, which may takes between 10 minutes to 60 minutes of CPU time, one hour to two days are necessary to analyze and evaluate the results. (33:627)

L. Transportation Model (TRANSMO)

The TRANSMO Model was developed and is used by the US Army Concepts Analysis Agency. The purpose of the model "is to determine the arrival time of US forces in overseas theaters of operation." (33:769) This is accomplished by scheduling the deployment of forces with specified transportation vehicles. The input is divided into three types of characteristics: force, lift vehicle, and general. The force characteristics include troop strengths, weights, origin, destination, resupply, consumption and cargo type. The lift characteristics are the speed, load and unload times, and capacity for each type of cargo. Finally, the general characteristics involved are port restrictions, distances between ports, and attrition factors. The output of the model provides a detailed summary of the deployment schedule. To utilize TRANSMO, one week is needed to acquire the data base and two man-weeks to transform the data into the proper input format. Then after about 15 minutes of CPU time, one man-week is necessary to analyze and evaluate the output.

Summary

In this chapter the different strategic deployment models have been reviewed. Though many models exist concerning the deployment of forces, none meet the objective of this research project. This is so for many reasons. First, the models are response oriented, as the specific units and the order of their deployment is determined previously. Second, the models do not address the problem of transhipping the supplies to the combat units forward of the APOD.(5:22). Third, the port capability of the APOD in receiving the intertheater shipments is not examined.

Finally, none of the models use goal programming to optimize the amount of delivered combat power. Therefore, none of the existing deployment models adequately addresses the objective of this project.

III. Model Development

In this chapter the mathematical expressions of the goals and constraints used in the model will be developed. These goals and constraints are taken from the thesis of Capt. Cooke and are adjusted to the form used in the computer program. Any differences between the two will be discussed in full detail. Prior to developing the goals and constraints, the variables, multipliers and subscripts will be defined. Next, the goals followed by the constraints will be derived. Following each constraint will be the number of that type constraint necessary for the model. Finally, a summary which will contain all the goals and constraints in their mathematical expression will be given.

Variable Parameters

The definition of the parameters will be discussed prior to the presentation of the model that was developed by Capt. Cooke. (4:46-76) The variables are defined as follows:

Variables used:

X(i,j,k,l): the number of delivered aircraft loads. [AC/PERIOD]

P(k,l): slack and surplus variables used in the equality constraints.

U(y,m,l): the number of units deployed. [UNITS/PERIOD]

Sl: the amount of supplies transshipped in period l from the APOD to the front. [TONS/PERIOD]

Subscripts used:

a: the APOD.

i: a specific type of aircraft, range is from 1 to I. The aircraft are identified by the user.

j: a specific type of mission, range is from 1 to J. In this model the missions are divided into four areas as follows: 1 = direct delivery, 2 = APOD delivery, 3 = intratheater delivery, and 4 = airborne delivery.

k: a specific type of cargo, range is from 1 to K. Here, the cargo is divided into five categories as follows: 1=outsize, 2=oversize, 3=bulk, 4=passengers only, and 5=supplies (considered to be bulk size cargo).

l: a specific period, range is from 1 to L.

m: the mode of delivery, range is from 1 to M. Here, the mode is divided into three methods as follows: 1=delivery to the front, 2=delivery via the APOD and remain at the APOD or move to the front on their own, and 3=delivery to the APOD and move to the front via intratheater airlift.

y: a specific type of unit, range is from 1 to Y. The units are identified by the user. The first Y′ are all those units deployed at the front.

Multipliers used:

AB(y): the airborne capability indicator for unit type y. The value is either 0 or 1.

AT(y): the anti-tank capability of type y unit expressed in equivalent TOEs.

AVAIL(i): the availability of type i aircraft.

CI(y): the Combat Indicator: 1 if a combat unit, -1 if a combat support unit, and 0 if neither a combat or combat

support unit.

CPI(l): the combat power index for arriving at the front in period l.

DAPDFT: the distance between the APOD and the front. [KM]

DUSAPD: the distance between the US and the APOD. [KM]

DUSFRT: the distance between the US and the front. [KM]

EAS(i,k): the standardizing factor for the MHE required to unload aircraft type i with type k cargo.

FLT(y): the front line trace capability of type y unit. [KM]

FP(y): the firepower capability of type y unit.

GAT(l): the desired goal for anti-tank power by period l. [TOE]

GFLT(l): the desired goal for front line trace by period l. [KM]

GFP(l): the desired goal for combat power by period l.

GT(i): the ground time for type i aircraft to offload, upload, and/or refuel. [HOURS/AC]

Ha: the material handling equipment capacity in pallet equivalents existing at the APOD prior to the deployment. [PALLETS/DAY]

Hf: the same as Ha, but for the front. [PALLETS/DAY]

INTER(i): the number of days required between intertheater missions. [DAYS]

INTRA(i): the number of days required between intratheater missions. [DAYS]

KARG(i,k): the cargo capacity of type i aircraft with type k cargo. [TONS/AC]

MHE(i): the pallet capacity of type i aircraft. [PALLETS]

My: the movement time required by a unit to go from the APOD to the front by ground transportation, rounded to the nearest integer. [PERIODS]

L: the number of periods considered in the model.

NPAL: the number of Pallet Equivalents (PE) that an ALCE unit can manage in one day.[PALLETS/DAY]

NPRK(i): the number of type i aircraft that can park on the ramp of the APOD. [AC]

NPK(y): the number of type y unit fighter aircraft that can park on the ramp of the APOD. [AC]

NTAC(y): the number of fighter aircraft assigned to type y unit. [AC/UNIT]

NUM(i): the number of type i aircraft in the inventory. [AC]

PL: the number of days in one period. [DAYS/PERIOD]

RC: the number of pallets the Army Riggers can prepare per day. [PALLETS/DAY]

SPD(i): the no-wind cruise speed of type i aircraft. [KM/HR]

TON(y,k): the amount of tonnage to move for type y unit of type k cargo. [TONS/UNIT]

TON(y,5): the supply consumption rate of type y unit. [TONS/UNIT/DAY]

TRP(y): the ton-mileage capability for the transportation of supplies to the front for type y unit. [TON*MILES/UNIT/DAY]

TVL(y): the amount of distance that type y unit can move in one day. [KM/DAY]

UNIT(y): the number of type y units available. [UNITS]

UTE(i,j): the utilization rate for type i aircraft on a type j mission. [HRS/DAY]

Goals

All combat attributes are not "mutually reinforcing", as some attributes are very effective in one area, but ineffective in other areas. If the attributes were "mutually reinforcing", then the objective could be met by simply deploying as much of the combat attributes as possible without regard to the type of units deployed. This is not the case, therefore decisions need to be made to balance the different units deployed. An aircraft squadron is a good example. Here, the aircraft are very effective at interdiction, but ineffective at maintaining terrain. The objective of this program is to meet the "requirements or specified goals" of the decision maker, and then to "maximize specific force attributes." Goal programming accomplishes this objective effectively, and is therefore utilized to meet the goals and force attributes.

The goals chosen to represent combat power are anti-tank (AT) capability, defensive frontage (front line trace or FLT), and firepower (FP). The first two goals do not depend upon time, while the last goal does depend upon time. The time-dependent variable implements a concept described in the 1981 Congressionally Mandated Mobility Study. (27:30) This concept proves that a small force delivered in the right place can be up to six times more effective than the same size force delivered at a later time. The time-independent goals will be discussed first, followed by the time-dependent goal. (5:50-6)

Included in the time-independent goals are the anti-tank (AT) and defensive frontage (FLT) goals. Since the anti-tank (AT) goals are independent of time, the amount of combat power each unit contributes is related only to the type of unit and the number of units deployed. Therefore, given the multiplier AT(y), which represents the amount of anti-tank potential a specific unit exhibits, the following expression represents the total anti-tank potential at time period l', assuming no attrition of units, for a given mode of transportation:

$$\sum_{y=1}^{Y'} \sum_{m=1}^{3} \sum_{l=1}^{l'} AT(y) * U(y,m,l)$$

The expression would be accurate if the units are delivered to the front and are available to act in combat upon arrival. Not all deliveries are made to the front by direct delivery, though. For units that arrive at the APOD, there are two means by which they can be delivered to the front. The first way is through self-delivery (m=2). That is, each unit has the capability to move itself by means that are organic to the unit. The second way for a unit to arrive to the front is through intratheater airlift (m=3). Each of these means will be discussed separately.

Self-delivery to the front (m=2) is the ability of a unit to move itself from one point to another point without the assistance of another unit. When considering this mode of travel, the time-distance relationship must be considered before the unit can be considered "closed to the combat area." This concept, "closed to the combat area," means that the unit is available to the ground commander to engage in action as needed. Therefore, all units delivered to the APOD are not considered as

contributing to the anti-tank potential until the unit has "closed". To consider this situation, "My" is defined as the closest integer of the distance from the APOD to the front (DAPDFT) divided by the distance the particular unit can travel in one day (TVL(y)) times the period length (PL) considered.

$$My = NINT\ [DAPDFT\ /\ (TVL(y) * PL)]$$

$$[dist]/([dist/day]*[days/period])=periods$$

The function NINT calculates the closest integer of the expression. Therefore, concerning self-delivery to the front from the APOD, the left-hand side (LHS) of the constraint is as follows:

$$\sum_{y=1}^{Y'} \sum_{l=1}^{l'-My} AT(y) * U(y,2,l)$$

Intratheater airlift (m=3) is the airlift within a particular theater of operations. The time-distance relationship is not considered because the flying time from the APOD to the front is assumed to be short with respect to the length of time per period. Therefore, given that troops and equipment are available at the APOD, the following expression gives the LHS of the constraint:

$$\sum_{y=1}^{Y'} \sum_{l=1}^{l'} AT(y) * U(y,3,l)$$

Finally, some units at the APOD may possess anti-tank potential and must be considered. A fighter squadron at the APOD is an example of such a unit. Units assigned to the APOD are assumed to be shipped only to the APOD. That is, a unit destined for the APOD would not be shipped to the front either by direct

or airborne delivery and then require transportation to the APOD. As a result of this, the time distance relationship between the APOD and the front is not considered. Therefore, the following expression considers units at the APOD that contribute to the total anti-tank power deployed:

$$\sum_{y=Y'+1}^{Y} \sum_{l=1}^{l'} AT(y) * U(y,2,l)$$

When all of these left hand sides are summed, the result is the total amount of anti-tank power deployed by time period l'. Therefore, given the fact that GAT(l') is the amount of anti-tank power desired by period l', the following is the mathematical expression of the goal:

$$\sum_{y=1}^{Y'} \sum_{l=1}^{l'} \sum_{m=1,3} AT(y) * U(y,m,l) \quad + \sum_{y=1}^{Y'} \sum_{l=1}^{l'-My} AT(y) * U(y,2,l)$$

$$+ \sum_{y=Y'+1}^{Y} \sum_{l=1}^{l'} AT(y) * U(y,2,l) \quad >= \quad GAT(l')$$

In the above expression, direct delivery (m=1) and intratheater delivery (m=3) are expressed in the first term. The second summation includes front units delivered to the APOD and able to move to the front independently. Finally, the third summation includes the units assigned to the APOD. (5:53)

The defensive frontage (FLT) goal is developed in the same fashion as the anti-tank (AT) goal. The multiplier FTL(y) is used to represent the amount of defensive frontage a specific unit contributes to the goal. Therefore, the expression

representing the desired amount of defensive frontage (FLT) by period l′ is as follows:

$$\sum_{y=1}^{Y'} \sum_{l=1}^{l'} \sum_{m=1,3} FLT(y) * U(y,m,l) + \sum_{y=1}^{Y'} \sum_{l=1}^{l'-My} FLT(y) * U(y,2,l)$$

$$+ \sum_{y=Y'+1}^{Y} \sum_{l=1}^{l'} FLT(y) * U(y,2,l) >= GFLT(l')$$

The third goal to be discussed is firepower. The only difference between this goal and the previously mentioned goals is that the firepower goal is time-dependent. This means that the worth of the same amount of firepower will change over time. If, though, the time-dependent portion of the goal is represented by a multiplier, then firepower would be similar to the other goals with the exception of the time-dependent multiplier. This time-dependent multiplier is defined as the combat power index CPI(l), and is dependent upon the period that the unit is "closed on the combat arena." The term FP(y) is the amount of firepower a specific unit contributes to the overall goal. Therefore, the expression for the desired amount of firepower by period l′ is as follows:

$$\sum_{y=1}^{Y'} \sum_{l=1}^{l'} \sum_{m=1,3} CPI(l) * FP(y) * U(y,m,l)$$

$$+ \sum_{y=1}^{Y'} \sum_{l=1}^{l'-My} CPI(l+My) * FP(y) * U(y,2,l)$$

$$+ \sum_{y=Y'+1}^{Y} \sum_{l=1}^{l'} CPI(l) * FP(y) * U(y,2,l) >= GFP(l')$$

Cooke does not adjust the time-dependent index to reflect the transportation delay from the APOD to the front. An adjustment is made here though because the index should reflect when the

unit is available for combat, not when it arrives at the APOD. (5:55)

The three types of goals used to measure combat power are anti-tank, defensive frontage, and firepower capability. The first two goals are not dependent upon time, while the third goal is time-dependent. All three goals were derived and are similar with the exception of the firepower goal. This goal was modified to include an additional multiplier to represent the time-dependent portion of the goal. Next, the factors which constrain the attainment of these goals will be examined in detail.

Bounding Constraints

The different sets of constraints that limit the attainment of the different goals will be examined. Some of these constraints may later be discussed as goals, but will presently be classified as constraints. These constraints involve both aircraft and units separately and jointly. A complete description and development is examined independently for each of the following constraints.

Aircraft Limitations: The limitation of aircraft is divided into two sets of constraints, aircraft availability and average utilization rates. The first constraint set will deal with the number of missions possible from the number of aircraft in the Air Force inventory and their respective availability to participate in the deployment. Then the second constraint set gives the number of missions anticipated given the expected number of hours per day the aircraft will be available to fly missions.

1. The first constraint set will reflect the number of aircraft sorties dependent upon the number of aircraft available and their availability rates. An important factor here is the portion of a day that is required between like missions. Because most of the intertheater missions would require more than one day, but less than two days for a round trip, there is some overflow from the previous day. Therefore, the following expression satisfactorily explains the number of sorties available for a deployment:

$$\text{Inter}(i) \; * \; \sum_{j=1}^{2,4} \; \sum_{k=1}^{K} \; X(i,j,k,l)$$

$$+ \; \text{Intra}(i) \; * \; \sum_{k=1}^{K} X(i,3,k,l) \quad <= \quad \text{NUM}(i) \; * \; \text{AVAIL}(i) \; * \; \text{PL}$$

There is no overflow considered between periods. Cooke considers the overflow between periods in his model because his period is equal to one day. The period length in DEPLOY is significantly larger than the Inter(i) term so realism is maintained by not considering overflow between periods. There is one constraint per aircraft type per period, or a total of (I*L).

2. This set of constraints considers the number of aircraft sorties in relationship to the expected utilization (UTE) rate. The UTE rate is "commonly used to define airlift capability" (12:7), and is the "fleetwide average flying hours per day per aircraft." The average number of sorties the fleet of a particular type of aircraft can be expected to fly in a period is as follows:

$$\sum_{i=1}^{I} \sum_{k=1}^{K} KARG(i,5) * X(i,4,5,l) - P(5,l-1) + P(5,l) = RC * PL$$

There is one constraint per period, or L constraints.

Summary

In this chapter, the mathematical expressions for the goals and constraints that are used in the model have been derived. The majority of the expressions were taken from the thesis of Capt Cooke with only a few minor changes. In addition, the variables, subscripts, multipliers and other terms used in the model were defined. Finally, a summary of the constraints is given with the total number of constraints that are in the model:

Goals-Time Independent

Anti-tank

$$\sum_{y=1}^{Y'} \sum_{l=1}^{l'} \sum_{m=1,3} AT(y) * U(y,m,l) + \sum_{y=1}^{Y'} \sum_{l=1}^{l'-My} AT(y) * U(y,2,l)$$

$$+ \sum_{y=Y'+1}^{Y} \sum_{l=1}^{l'} AT(y) * U(y,2,l) \geq GAT(l')$$

One for each goal.

Front Line Trace

$$\sum_{y=1}^{Y'} \sum_{l=1}^{l'} \sum_{m=1,3} FLT(y) * U(y,m,l) + \sum_{y=1}^{Y'} \sum_{l=1}^{l'-My} FLT(y) * U(y,2,l)$$

$$+ \sum_{y=Y'+1}^{Y} \sum_{l=1}^{l'} FLT(y) * U(y,2,l) \geq GFLT(l')$$

One for each goal.

support unit. This term adds one constraint to the problem. (5:71)

2. A common example of a unit linkage floor is "the relationship between combat units and combat service support units, such as headquarters [HQ] units." One way to express at least a 1 to 5 ratio of HQ's units to battalion units is:

$$\text{cmbt} - 5\text{HQ} <= 0.$$

A problem with this is that, in the initial deployment, a HQ unit must precede the combat battalion. This is clearly not desired in the model or reality. A better expression is,

$$\text{cmbt} - 3\text{HQ} <= 2.$$

Here two combat units could deploy before a HQ unit is required. Furthermore, one HQ unit could handle a maximum of five battalions, and two HQ units could maintain up to eight battalions. This expression conforms more accurately to the present doctrine and practice. As a result, this expression "would add one constraint for each linkage between combat units and other type of units." (5:72)

<u>Unit Abilities</u>: Unit abilities is the last set of constraints to be examined. Here the airdrop capability is limited by the personnel responsible for the preparation of loads for the airdrop. Mathematically this is expressed as,

$$\sum_{i=1}^{I} \sum_{k=1}^{K} \text{KARG}(i,5) * X(i,4,k,l) <= \text{RC} * \text{PL}$$

As in the case of the shipment of units, the previous period's surplus, P(5,l-1), and the present period's surplus, P(5,l), change the constraint to be an equality.

as in the last constraint, only the first Y′ units are deployed at the front while the remainder (Y′+1,...,Y) are deployed at the APOD. There is one constraint per period or a total of L constraints. (5:70)

Unit Linkage: This section describes certain ceilings and floors of the particular units deployed in relation to other units deployed. When considering its ceiling, more of a particular unit cannot be deployed without a corresponding increase in another type of unit. Conversely, a floor requires the deployment of a particular unit in order for another unit to increase the number that are deployed. Both of these terms keep certain units in a particular predetermined ratio. First a specific case of a ceiling will be discussed, followed by an example of a floor.

1. An example of a ceiling is "the deployment of combat support arms such as artillery, requiring a minimum number of combat units to be deployed before more follow-on artillery" are deployed. In order to keep the ratio between combat designated units and combat support units in at least a one-to-one ratio, the following expression is used:

$$\sum_{y=1}^{Y} \sum_{m=1}^{3} \sum_{l=1}^{L} CI(y) * U(y,m,l) >= 0.$$

Here, the multipliers CI(y) are combat indicator variables to distinguish between combat, combat support, and other units, and are given the values 1, -1, and 0 respectively. The first two types are self explanatory. An example of an "other" unit would be the ALCE as it is considered neither a combat nor a combat

$$\sum_{i=1}^{I} \sum_{j=1,4} KARG(i,5) * X(i,j,5,l') + SI + P(5,l'-1)$$

$$- \sum_{y=1}^{Y'} \sum_{m=1}^{3} \sum_{l=1}^{l'-1} PL * TON(y,5) * U(y,m,l) - P(5,l) = 0.$$

and

$$\sum_{i=1}^{I} KARG(i,5) * X(i,3,5,l')$$

$$+ \sum_{y=1}^{Y} \sum_{m=1}^{3} \sum_{l=1}^{l'-My} [TRP(y) * PL]/[2 * DAPDFT] * U(y,m,l) >= SI$$

There are two constraints per period or a total of 2*L constraints. (5:68-9)

3. The constraint of supplies for the APOD will be discussed in this section. As in all the other cases, supply must equal or exceed the requirements of the deployed units. Supplies that come into the APOD are either consumed by local deployed units or shipped to the front by deployed truck units or intratheater aircraft missions. The supply constraint, then, is the sum of the supplies delivered to the APOD, plus the surplus supplies from the previous period, minus that which is consumed at the APOD, minus supplies transshipped to the front, and minus the excess supply for the period. The result is as follows:

$$\sum_{i=1}^{I} KARG(i,5) * X(i,2,5,l') + P(5,l'-1) - SI - P(5,l')$$

$$- \sum_{y=Y'+1}^{Y} \sum_{l=1}^{l'-1} PL * TON(y,5) * U(y,2,l) = 0.$$

The SI term relates to the previous supply constraint at the front and is the amount that is sent forward to the front. Also,

$$\sum_{i=1}^{I} \sum_{j=1,3}^{4} KARG(i,5) * X(i,j,5,l')$$

$$+ \sum_{y=1}^{Y} \sum_{m=1}^{3} \sum_{l=1}^{l'-My} [TRP(y) * PL]/[2 * DAPDFT] * U(y,m,l)$$

$$- \sum_{y=1}^{Y'} \sum_{m=1}^{3} \sum_{l=1}^{l'-1} PL * TON(y,5) * U(y,m,l) \quad >= \quad 0.$$

Another constraint must be added to the above expression to ensure that aircraft and trucks do not ship supplies that are not available at the APOD. By letting Sl equal the supplies transshipped during period l, the parameter is limited to the capacity of the transshipment pipeline. This is similar to stating that the actual amount supplied cannot exceed the capability of moving supplies to the front from the APOD. Here, the variable TRP(y) functions as an indicator variable, in that if the unit considered is not a transportation unit, the value is zero. The expression for period l' is then as follows:

$$\sum_{i=1}^{I} KARG(i,5) * X(i,3,5,l')$$

$$+ \sum_{y=1}^{Y} \sum_{m=1}^{3} \sum_{l=1}^{l'-My} [TRP(y) * PL]/[2 * DAPDFT] * U(y,m,l) \quad >= \quad Sl$$

Furthermore, the value of Sl must be less than or equal to the amount of supplies left over at the APOD. This additional constraint will be discussed further in the constraints of supplies for the APOD. Therefore, the final constraints when considering slack and surplus variables are as follows:

deliveries (j=1), intratheater missions (j=3), and airborne deliveries (j=4). Mathematically, this is expressed as follows:

$$\sum_{i=1}^{I} \sum_{j=1,3}^{4} KARG(i,5) * X(i,j,5,1)$$

When considering the transportation of supplies via truck, the time-distance relationship must be considered along with the unit's capability of moving supplies. Each unit has an input parameter of the number of ton-miles the unit can move per day [TRP(y)]. A combat unit though is normally given a parameter equal to zero. This means that the combat unit can only move supplies from its rear area to its front. The following expression determines the number of tons a unit can move in one period.

$$[TRP(y) * PL] / [2 * DAPDFT]$$

$$[\text{ton-miles/day}] * [\text{days/period}] / [\text{miles}] = [\text{tons/period}]$$

The two in the denominator reflects the round trip distance from the APOD to the front. Therefore, the total tonnage shipped via truck is as follows:

$$\sum_{y=1}^{Y} \sum_{m=1}^{3} \sum_{l=1}^{l'-My} [TRP(y) * PL]/[2 * DAPDFT] * U(y,m,l)$$

By combining the expressions for the amount of supplies brought to the front and subtracting the consumption of the supplies by the units deployed to the front, the resulting expression is formed:

for the remainder of the period. Therefore, given the parameter TON(y,5) as the daily consumption rate of a specific unit, the supply constraint for period l′ is:

$$\sum_{i=1}^{I} \sum_{j=1}^{2,4} KARG(i,5) * X(i,j,5,l') + P(5,l'-1)$$

$$- \sum_{y=1}^{Y} \sum_{m=1}^{3} \sum_{l=1}^{l'-1} TON(y,5) * PL * U(y,m,l) - P(5,l') = 0.$$

Here P(5,l′) represents the surplus supplies shipped in the l′th period, while P(5,l′-1) is the surplus carried forward from the previous period. Again, it is assumed here that each unit upon its deployment has sufficient supplies to sustain itself for the remainder of the period. There is one constraint for each period or L constraints. (5:67)

2. Here, the constraints to ensure adequate supplies reach the front are discussed. Every unit not based at the APOD is considered to consume its supplies at the front. In other words, all the units with the exception of the APOD-ALCE, the fighter squadrons and the transportation units consume their supplies at the front. In the file that contains the information on the different units, the first Y′ units are deployed to the front, while the others are deployed to the APOD. Delivery to the front can take place by one of four means;

a. direct delivery,
b. airborne delivery,
c. transportation via intratheater airlift, and
d. transshipment via truck.

The last means of delivery, by truck, will be discussed separately. The expression of the total amount of supplies delivered by airlift is simply the sum of the number of direct

if the unit is not airborne capable. The expression then becomes,

$$\sum_{i=1}^{I} KARG(i,k) * X(i,4,k,l) - \sum_{y=1}^{Y'} AB(y) * TON(y,k) * U(y,1,l)$$

$$+ P(k,l-1) - P(k,l) = 0.$$

Once again, there is one constraint for each period and cargo type, or L*K (K=4) constraints. (5:66)

Shipment of Supplies: Supplies are included in a separate classification (k=5), and are used to describe the aggregate needs to sustain a unit. Therefore, once units are delivered to the theater, there is a requirement to sustain the unit with a certain tonnage of supplies. Therefore, the input must equal or exceed the consumption of supplies by the deployed units. Three different sections will be discussed concerning this issue. The first section will insure that there are adequate supplies delivered to the theater to meet the needs of all the different units in the theater. Then, the second section will insure that the necessary supplies reach the units deployed to the front. Finally, the last section will insure adequate supplies are available for the units based at the APOD. Each of these sections will be examined in turn.

1. The requirement for intertheater supplies is very similar to the shipment of units previously mentioned. There is one difference though; all the units that have "closed" in the previous periods are those receiving the supplies. The supplies are delivered only for the units deployed in the previous periods because it is assumed that each deployed unit has enough supplies

$$\sum_{i=1}^{I} KARG(i,k) * X(i,2,k,l) - \sum_{y=1}^{Y}\sum_{m=2}^{3} TON(y,k) * U(y,m,l) >= 0$$

However, because excess cargo [P(k,l)] or early cargo [P(K,l-1)] must also be considered, these variables should also be included in the constraint.

$$\sum_{i=1}^{I} KARG(i,k) * X(i,2,k,l) - \sum_{y=1}^{Y}\sum_{m=2}^{3} TON(y,k) * U(y,m,l)$$
$$+ P(k,l-1) - P(k,l) = 0.$$

Finally, to ensure that cargo moved to the APOD reaches the front, an additional constraint is added:

$$\sum_{i=1}^{I} KARG(i,k) * X(i,3,k,l) - \sum_{y=1}^{Y} TON(y,k) * U(y,3,l) >= 0$$

There are two constraints for each period and cargo size, or L*K (K=4) constraints. (5:65-6)

2. The shipment of units to the front via direct delivery is very similar to the shipment of units to the APOD. Therefore, the expression to indicate the closure of units to the front by direct delivery is:

$$\sum_{i=1}^{I} KARG(i,k) * X(i,1,k,l) - \sum_{y=1}^{Y'} [1-AB(y)] * TON(y,k) * U(y,1,l)$$
$$+ P(k,l-1) - P(k,l) = 0.$$

As before, there is one constraint for each period and cargo type, or L*K (K=4) constraints. (5:66)

3. The shipment of units to the front via airdrop is also similar to the previous constraint with one minor difference. To insure that only airborne capable units are delivered, an indicator variable AB(y) is necessary. The value of AB(y) is equal to one if the unit is airborne capable, or is equal to zero

arriving first to APOD and then transporting themselves to the front. If the ALCE units were unable to move themselves, the third summation would not exist. There is one constraint per period for both the APOD and the front, or 2*L constraints. (5:63-4)

Unit Limitation: The number of units shipped is obviously limited by the number of units available. Therefore, this constraint is simply expressed as the following:

$$\sum_{m=1}^{3} \sum_{l=1}^{L} U(y,m,l) <= UNIT(y).$$

There is one constraint for each type of unit, or a total of Y constraints. (5:64)

Shipment of Units: This section will discuss the three different ways that units can be shipped into the theater. These three ways are via the APOD, airborne delivery, and direct delivery.

1. The delivery completion time for the units to the APOD is examined in this section. When a unit is transported in its entirety, the unit is said to be "closed." All fighter aircraft squadrons, and transportation units are assumed to be delivered and assigned to the APOD. ALCE units are unique in that they are assigned to either the front or the APOD. Each unit is described in terms of personnel and outsize, oversize and bulk tonnage. Therefore, the unit cannot be "closed" until all the personnel and tonnage of each type of cargo for the unit is delivered. The mathematical expression of this is as follows:

pallet equivalents that an ALCE unit can download in one day. Since the period here spans many days, an arbitrary term of less than one is multiplied by the number of newly arriving ALCE units. The multiplier in this case is one-half. This will more closely approximate the additional assistance gained from the newly arriving ALCE units than if the periods were treated similar to a single day. Finally, because the number of aircraft "moving through the APOD must not be greater than the capabilities at the airport to unload them", the following constraints for period l′ are established:

For the APOD:

$$\sum_{i=1}^{I} \sum_{j=2,3} \sum_{k=1}^{K} EAS(i,k) * MHE(i) * X(i,j,k,l')$$

$$- \sum_{l=1}^{l'-1} NPAL * PL * U(ALCE,2,l)$$

$$- .5 * NPAL * PL * U(ALCE,2,l') \quad <= \quad Ha * PL$$

For the front:

$$\sum_{i=1}^{I} \sum_{j=1,3} \sum_{k=1}^{K} EAS(i,k) * MHE(i) * X(i,j,k,l')$$

$$- \sum_{l=1}^{l'-1} \sum_{m=1,3} NPAL * PL * U(ALCE\text{-}FRONT,m,l)$$

$$- \sum_{l=1}^{l'-My} NPAL * PL * U(ALCE\text{-}FRONT,2,l)$$

$$- \sum_{m=1,3} .5 * NPAL * PL * U(ALCE\text{-}FRONT,m,l') \quad <= \quad Hf * PL$$

Concerning the constraints at the front, the second summation considers the ALCE units arriving either by direct or intratheater delivery. The third summation, considers ALCE units

A special situation to consider here is the case of fighters assigned to the APOD. If this is the circumstance, the fighters must be assured available ramp space at all times. Therefore, by combining this constraint to the previous constraint, the result is as follows:

$$\sum_{i=1}^{I} \sum_{j=2}^{3} \sum_{k=1}^{K} X(i,j,k,l) * GT(i) / [PL * NPRK(i) * 24]$$

$$+ \sum_{y=Y'+1}^{Y} U(y,2,l) * NTAC(y) / [PL * NPK(y)] \quad <= \quad 1.$$

[units/period]*[AC/unit]*[24hrs]/([days/period]*[AC]*[24hrs/day])

The 24 in the numerator and the denominator cancel out, but the units are important to show the relationships between the variables. There is one constraint for each period considered, or a total of L constraints. (5:62-3)

2. This section reviews the constraints of material handling equipment (MHE) at the APOD and front. The time to off-load an aircraft is dependent upon the number of pallets the aircraft can hold and the type of cargo being off-loaded. The number of pallets an aircraft can hold (NPAL) is easily determined, while the relative ease with which these pallets are offloaded is not. Therefore, the variable EAS(i,k) measures the relative ease with which pallets for type i aircraft with type k cargo can be off-loaded. If all the aircraft and cargo can be removed with the same ease, the variables are all equal to one. The resources available to download the aircraft are the MHE available prior to the deployment (Ha for the APOD and Hf for the front), and the ALCE with its "ancillary port improvement packages" (APAL). The variable APAL measures the number of

considers the amount of ramp parking space available for the aircraft at the APOD. The second constraint of MHE will interface with the capability to unload an aircraft once it has arrived at the APOD or front.

1. This set of constraints considers the limited amount of ramp space available at the APOD. A linear relationship is assumed between the area required for different type of aircraft. Specifically, if the ramp is sufficient to park a total of 48 F-16's or 12 C-130's, the ramp is also sufficient to park 24 F-16's and 6 C-130's, or any convex combination thereof. This approximation is adequate for most "airfields except very small fields with end-point solutions to parking limitations." Here a large aircraft could block off a taxiway or runway from other aircraft. Normally though, this is not a problem because APOD's are normally not "chosen at minimally capable terminals." (5:61)

The parameter which considers ramp space is parking-space required per unit time for each type of aircraft. Here, it is assumed the aircraft is unloaded and serviced within the planned ground time (GT(i)). This parameter is constrained as follows:

$$\sum_{i=1}^{I} \sum_{j=2}^{3} \sum_{k=1}^{K} X(i,j,k,l) * GT(i) \;/\; [PL * NPRK(i) * 24] \;<=\; 1.$$

[AC/period]*[hrs]/([days/period]*[AC]*[hrs/day])

Here, j is summed only over the missions that transit the APOD. Also, all the units for the terms are cancelled out, leaving a unitless constraint. When the left hand side of the constraint is equal to one, the ramp space is completely saturated.

$$[PL * UTE(i,j) * NUM(i) * SPD(i)] / [2 * DUSAPD].$$

$$[\text{days/period} * \text{hours/day} * \text{aircraft} * \text{km/hour}]/[\text{km}] = \text{aircraft/period}$$

The number "2" in the denominator reflects the aspect of a round trip, the total distance flown. When considering only the aircraft that are involved in the deployment, and not the entire fleet of a particular aircraft, the above expression must be multiplied by the percentage of the aircraft that will be available in the deployment. Cooke does not include this last factor, but should, as without it, he is saying that all the flying time for a particular aircraft type is consumed by the aircraft in the deployment.

$$[PL * UTE(i,j) * NUM(i) * AVAIL(i) * SPD(i)] / [2 * DUSAPD].$$

$$[\text{days/period} * \text{hours/day} * \text{aircraft} * \% * \text{km/hour}]/[\text{km}] = \text{aircraft/period}$$

Therefore, the average number of a specific aircraft that will fly in a given period must be less than or equal to the above expression. By rearranging some of the terms and summing over the missions and cargo, the following constraint is developed:

$$\sum_{j=1}^{J} \sum_{k=1}^{K} [1/UTE(i,j)] * X(i,j,k,1')$$

$$<= [PL * NUM(i) * AVAIL(i) * SPD(i)] / [2 * DUSAPD]$$

Cooke uses a standardizing factor to convert aircraft of the same type, flying different missions to an equivalent number of sorties for the respective mission. The ratio used is as follows:

[Distance other] / [Distance from the US to APOD]

This ratio shows that there are more sorties available for

Fire Power

$$\sum_{y=1}^{Y'} \sum_{l=1}^{l'} \sum_{m=1,3} CPI(l) * FP(y) * U(y,m,l)$$

$$+ \sum_{y=1}^{Y'} \sum_{l=1}^{l'-My} CPI(l+My) * FP(y) * U(y,2,l)$$

$$+ \sum_{y=Y'+1}^{Y} \sum_{l=1}^{l'} CPI(l) * FP(y) * U(y,2,l) \quad >= \quad GFP(l')$$

One for each goal.

Aircraft Sorties

$$Inter(i) * \sum_{j=1}^{2,4} \sum_{k=1}^{K} X(i,j,k,l)$$

$$+ \quad Intra(i) * \sum_{k=1}^{K} X(i,3,k,l) \quad <= \quad NUM(i) * AVAIL(i) * PL$$

One for each aircraft type and period.

Aircraft UTE Rate

$$\sum_{k=1}^{K} \sum_{j=1,4} [1/UTE(i,j)] * [DUSFRT/DUSAPD] * X(i,j,k,l')$$

$$+ \sum_{k=1}^{K} [1/UTE(i,2)] * X(i,2,k,l')$$

$$+ \sum_{k=1}^{K} [1/UTE(i,3)] * [DAPDFT/DUSAPD] * X(i,3,k,l')$$

$$<= [PL * NUM(i) * AVAIL(i) * SPD(i)] / [2 * DUSAPD]$$

One for each aircraft type and period.

Airport Ramp Space

$$\sum_{i=1}^{I} \sum_{j=2}^{3} \sum_{k=1}^{K} X(i,j,k,l) * GT(i) / [PL * NPRK(i) * 24]$$

$$+ \sum_{y=Y'+1}^{Y} U(y,2,l) * NTAC(y) / [PL * NPK(y)] \quad <= \quad 1.$$

One for each period.

Airport MHE

For the APOD:

$$\sum_{i=1}^{I} \sum_{j=2,3} \sum_{k=1}^{K} EAS(i,k) * MHE(i) * X(i,j,k,l')$$

$$- \sum_{l=1}^{l'-1} NPAL * PL * U(ALCE,2,l)$$

$$- .5 * NPAL * PL * U(ALCE,2,l') \quad <= \quad Ha * PL$$

For the front:

$$\sum_{i=1}^{I} \sum_{j=1,3} \sum_{k=1}^{K} EAS(i,k) * MHE(i) * X(i,j,k,l')$$

$$- \sum_{l=1}^{l'-1} \sum_{m=1,3} NPAL * PL * U(ALCE\text{-}FRONT,m,l)$$

$$- \sum_{l=1}^{l'-My} NPAL * PL * U(ALCE\text{-}FRONT,2,l)$$

$$- \sum_{m=1,3} .5 * NPAL * PL * U(ALCE\text{-}FRONT,m,l') \quad <= \quad Hf * PL$$

One for each period.

Unit Limitation

$$\sum_{m=1}^{3} \sum_{l=1}^{L} U(y,m,l) <= UNIT(y).$$

One for each deployable unit type.

Shipment of Units to the APOD

$$\sum_{i=1}^{I} KARG(i,k) * X(i,2,k,l) - \sum_{y=1}^{Y}\sum_{m=2}^{3} TON(y,k) * U(y,m,l)$$

$$+ P(k,l-1) - P(k,l) = 0.$$

and

$$\sum_{i=1}^{I} KARG(i,k) * X(i,3,k,l) - \sum_{y=1}^{Y} TON(y,k) * U(y,3,l) \quad >= \quad 0$$

Two for each period and cargo size.

Shipment of Units via Direct Delivery

$$\sum_{i=1}^{I} KARG(i,k) * X(i,1,k,l) - \sum_{y=1}^{Y'} [1-AB(y)] * TON(y,k) * U(y,1,l)$$

$$+ P(k,l-1) - P(k,l) = 0.$$

One for each period and cargo size.

Shipment of Units via Airdrop

$$\sum_{i=1}^{I} KARG(i,k) * X(i,4,k,l) - \sum_{y=1}^{Y'} AB(y) * TON(y,k) * U(y,1,l)$$

$$+ P(k,l-1) - P(k,l) = 0.$$

One for each period and cargo size.

Theater Supplies

$$\sum_{i=1}^{I}\sum_{j=1}^{2,4} KARG(i,5) * X(i,j,5,l') + P(5,l'-1)$$

$$- \sum_{y=1}^{Y}\sum_{m=1}^{3}\sum_{l=1}^{l'-1} TON(y,5) * PL * U(y,m,l) - P(5,l') \quad = \quad 0.$$

One for each period.

Front-Line Supplies

$$\sum_{i=1}^{I} \sum_{j=1,4} KARG(i,5) * X(i,j,5,l') + SI + P(5,l'-1)$$

$$- \sum_{y=1}^{Y'} \sum_{m=1}^{3} \sum_{l=1}^{l'-1} PL * TON(y,5) * U(y,m,l) - P(5,l) = 0.$$

and

$$\sum_{i=1}^{I} KARG(i,5) * X(i,3,5,l')$$

$$+ \sum_{y=1}^{Y} \sum_{m=1}^{3} \sum_{l=1}^{l'-My} [TRP(y) * PL]/[2 * DAPDFT] * U(y,m,l) >= SI$$

One for each period.

APOD Supplies

$$\sum_{i=1}^{I} KARG(i,5) * X(i,2,5,l') + P(5,l'-1) - SI - P(5,l')$$

$$- \sum_{y=Y'+1}^{Y} \sum_{l=1}^{l'-1} PL * TON(y,5) * U(y,2,l) = 0.$$

One for each period.

Link of Combat and Combat Support

$$\sum_{y=1}^{Y} \sum_{m=1}^{3} \sum_{l=1}^{L} CI(y) * U(y,m,l) >= 0.$$

One.

Link of Units and HQ's Units

$$cmbt - 3HQ <= 2.$$

One for each HQ's Unit.

Rigger Capability

$$\sum_{i=1}^{I} \sum_{k=1}^{K} KARG(i,5) * X(i,4,5,l) - P(5,l-1) + P(5,l) = RC * PL$$

One for each period.

The upper limit for the total number of aircraft variables is I * J * K * L, while for the unit variables it is Y * M. However, because many of the combinations are nonexistant, the number of actual variables necessary is considerably less than the upper limit. The number of equations from the constraints, in order, is # Goals + 2(I*L) + 3L + Y + 4(L*K) + 4L + 1 + #HQs + L, or # Goals + # HQs + 2(I*L) + 4(L*K) + 8L + Y + 1.

IV The General Model

Introduction

DEPLOY is an interactive goal programming model for the rapid deployment of armed forces. The program PAGP (Partitioning Algorithm for Goal Programming) is used for the allocation routine.(3:378-86) This chapter will discuss goal programming (GP) in general along with its relationship to linear programming (LP). As a result, this chapter will serve as an introduction to those not familiar with GP and act as a review to those who are well acquainted with GP. Then in the second section, the PAGP program will be examined as to why it was chosen and the efficiencies associated with it. PAGP was acquired from the Association for Computing Machinery (ACM) and, because it is copyrighted, cannot be used for commercial use without permission.

Goal Programming

Linear Programming (LP) is a very powerful and useful tool, but its "major criticism ... is that only one objective is permitted." (12:358) When only one objective is used, the "goals must be measured on a common scale." (12:358) Often though, decision makers are confronted with more than one objective such as maximizing total profits or minimizing total costs. A few of the many objectives may be improving the workers' morale, paying dividends to the stockholders, and meeting the consumers' needs. All of these objectives would be very difficult to put on a common scale. This is certainly true when considering the rapid deployment of armed forces. Here, the objective is to maximize delivered combat power without jeopardizing the sustainability of

the deployed forces. The problem with using LP is that combat power cannot be expressed on a common scale, but rather is measured in relationship to the amount of anti-tank power, front line trace and firepower a specific unit projects. Goal Programming (GP) can manage multiple objectives and for this reason is used for the general allocation routine.

In discussing GP, the set-up process and the assignment process will be explained, followed by the mathematical expression. Each objective must be formulated with a specified numerical goal in the set-up process. This is similar to the objective function in LP except the desired level or outcome of the objective must be specified. Next, the assignment of values to the decision variables is such that the weighted sum of the deviation variables from the objective function's goal is minimized. (8:172) Mathematically this is expressed as,

$$\min f = \sum_{i} [\, P(k) * W(i,k) * d(i)^{+} + P(s) * W(i,s) * d(i)^{-} \,]$$

st:

$$\sum_{j=1}^{n} M(i,j) * X(j) + d(i)^{-} - d(i)^{+} = g(i) \quad i=1,\ldots,p$$

$$\sum_{j=1}^{n} A(i,j) * X(j) <= b(i) \quad i=p+1,\ldots,p+m$$

$$X(j), d(i)^{-}, d(i)^{+} >= 0 \quad j=1,\ldots,n; \; i=1,\ldots,p \quad (12:371)$$

The first summation is the weighted sum of deviations from the objective function. Here, the W(i,k) is the assigned weight of the deviation variable d(i) for priority k, while the P's are the priority factors of the specific priority. By assigning weights to the deviation variables, it is possible to prioritize the

goals within the same level. These variables will be discussed more extensively in the following paragraphs. The second summation is the goal objectives with "g(i)" being the specified level of goal "i". Finally, the last summation is the normal constraints similar to those found in an LP problem.

The priority factors are also called preemptive-priority factors. This indicates that "any goal at preemptive-priority k (designated P(K)) will always be preferred to (i.e., preempt) any goal at a lower priority k+1,...,K, regardless of any scalar multiplier $W(i,k)^+$ or $W(i,k)^-$ associated with these lower priorities." (4:57) To understand the preemptive aspect, consider, for example, a possible decision process of selecting a house to buy. Suppose the buyer's first priority is that the house be within a 10-mile radius from his place of work. All homes that lie outside the 10-mile radius are not considered. Next, suppose the buyer wants to consider only houses under $120,000. As a result, even though houses less than $120,000 may exist outside the 10-mile radius, they are not considered and "are excluded (or preempted) from consideration by the first priority." (4:57) Therefore, "the preemptive-priority concept is used in the decision analysis as an iterative screening process." (9:380-81)

The final factors to be discussed are the deviation variables. These variables are defined as either positive or negative deviation variables. Further, they provide a means to measure both the underachievement and overachievement of a goal. By minimizing either one or both, the goal is defined as either a

ceiling, floor or equality. The following chart specifies which variable to minimize for a specific goal.

GP Form: $f(i) + d(i)^- - d(i)^+ = g(i)$

$f(i) <= g(i)$: ceiling minimize $d(i)^+$,
$f(i) = g(i)$: equality minimize $d(i)^+$ & $d(i)^-$, or
$f(i) >= g(i)$: floor minimize $d(i)^-$ (9:377)

The deviation variables, therefore, are used to measure the amount that the goals differ from what is desired.

In this section, the difficulty associated with LP was discussed along with how GP compensates by being able to manage multiple objectives. Then, the capability of GP was related to the need of DEPLOY, managing multiple objective functions. In addition, the setup and assignment processes were examined along with the mathematical expression of GP. Finally, the functions of the priority factors and deviation variables were discussed.

PAGP

The PAGP routine was chosen among other routines for several reasons, including its ability to efficiently allocate resources. First, the program had proved itself as an efficient allocation routine in a nuclear exchange model (BRIK) by Capts. Bunnell and Tackacs. (4:66,69) PAGP could also be employed as a subroutine in DEPLOY and therefore increase the portability of the model by not being bound to a necessary library routine. in addition to this, PAGP has been shown to be more efficient than one of the other popular GP packages done by Lee. (3:381-84) The key to PAGP's efficiencies is that the goal constraints are partitioned, some variables are eliminated, and a special termination rule is employed. Each of these efficiencies will be discussed in the following paragraphs.

The partitioning of goal constraints is the first efficiency of PAGP to be examined. This partitioning "is accomplished by observing that, for any goal constraint i, one and only one of the three things may occur.

(1) only $d(i)^-$ appears in the objective function,
(2) only $d(i)^+$ appears in the objective function,
(3) both $d(i)^-$ and $d(i)^+$ appear in the objective function."(3:379)

In case (1) the partition would assign goal constraint i to the priority factor associated with $d(i)^-$; in case (2) constraint i would be assigned to the priority factor associated with $d(i)^+$; while in case (3) the partition would determine the higher order priority factor (in terms of the ordinal ranking) associated with either $d(i)^-$ or $d(i)^+$ and constraint i would be assigned to that priority". (3:379) When real constraints are involved, they are considered before any of the goals and are treated first. Then when the real constraints have been satisfied, the constraints that have deviation variables in priority one are considered. New priorities continue to enter one by one until either all the priorities are considered or the special stopping rules are initiated. By partitioning the goal constraints, the problem is divided into subproblems which are solved in turn, resulting in improved efficiency.

The next efficiency of PAGP to be discussed is the elimination procedure. "The motivation behind the elimination procedure comes from the theory of LP." When a standard LP problem is optimized, "x(j) cannot enter the basis to form an alternate optimal solution" where $z(j) - c(j) > 0$. A corollary to this theorem is "in the standard GP problem, if the optimal

tableau for subproblem $S(K)$ has been found, then any nonbasic variable $t(s)$ (where $t(s)$ can be a decision variable or a deviation variable) which has at least one positive relative cost $[z(j)-c(j) > 0]$ can be eliminated from entering the basis in subproblems $S(k+1),\ldots,S(p)$." As a result of this procedure, fewer nonbasic variables are considered for entry into the basis, making the algorithm more efficient. (3:380)

The final efficiency to be investigated is the special stopping rule. When the program determines at a subproblem that there are no nonbasic variables to enter the basis, the stopping rule is invoked. This rule is initiated regardless of the number of lower priorities remaining to be considered. Therefore, when there is no possibility of improving, the problem terminates. This, like the other aspects of PAGP discussed, causes this program to be more efficient.

Conclusion

This chapter has described the general model of DEPLOY as a GP model that incorporates the program PAGP for the allocation routine. The basics of GP were reviewed along with its advantage over normal LP and how it satisfies the requirement of multiple objectives generated from DEPLOY. Furthermore, the efficiencies of PAGP were investigated as to why the routine was chosen to support DEPLOY. This concludes the examination of the general model, and in the next chapter the model characteristics of DEPLOY will be discussed.

V. Model Characteristics

This chapter examines two characteristics of DEPLOY. The first section discusses the model restrictions along with the scenario limitations concerning the application and usefulness of the model. In the second section, the input parameters necessary for DEPLOY will be reviewed.

Limitations

E. S. Quade is quoted as saying, "All of the assumptions of a model must be made explicit ... so his (the modeler's) errors will be more evident".(11:219) Though assumptions do not "necessarily reflect errors, they do represent the modeler's perception of the real world".(4:26) As a result, it is paramount that before any model is used, the assumptions and limitations be known to the user. Therefore, the limitations of DEPLOY are plainly stated, not to reveal error, but rather to give the user necessary information. This section is divided into two areas, the first area reviews the model restrictions while the second area discusses the scenario limitations.

Model Restrictions: DEPLOY's application and usefulness are restricted by the following factors:

1. Constant availability of Aircraft. The availability of aircraft is constant throughout the time periods considered in the model. That is, an aircraft cannot become more or less available from one period to the next. The only exception to this is when considering the first period the aircraft is available. Before the first period of availability, the aircraft is not considered as a possible resource to deploy units. At the first period of availability, the number of aircraft considered

as resources is a fixed constant ratio of the number of aircraft in the inventory. This fixed constant ratio is user-defined.

2. No individual scheduling between aircraft and deployed units. Aircraft in the model move cargo identified by the size and period in which it is shipped. There is no attempt to identify particular cargo with a specific deployed unit. As a result, an aircraft may be transporting several units at once, or just one unit. There is no distinction made between these two situations. This is employed in an attempt to minimize the number of different variables in the model. The process is valid because in order for a unit to "close", a specific number of passengers and different sizes of cargo must be transported. The number of each is determined by the unit "closing", therefore there is no need to specify the type of unit with a particular aircraft.

3. Non-integer solutions. The number of resources utilized and the number of units deployed are not restricted to integers. Therefore, the solutions will most likely include non-integer solutions.

4. No synergistic effect between units. The measure of effectiveness of all deployed units is independent of the number and type of other units deployed. That is, two mechanized battalions have the same effectiveness whether there are ten or no artillery battalions deployed.

5. Linear relationship of effectiveness of deployed units. There is a linear relationship between the total effectiveness of deployed units and the number of units deployed. What is meant

here is that the total effectiveness of ten deployed mechanized battalions is ten times the effectiveness of one mechanized battalion. This is realistic if, in the case here, there are a few number of units to deploy.

6. Only one APOD considered. There is only one APOD that aircraft can fly into to deliver troops and cargo. The decision to limit the model to one APOD was made in order to keep the matrix dimensions small without losing the realism. By adding another APOD, the constraint matrix would increase considerably.(7:79)

Scenario Limitations: The possible scenarios in a model are an important factor in any analysis. If the scenario of the model is not similar to the situation on hand, then the results of the model will not accurately measure the real outcomes. Therefore, the scenarios of DEPLOY are explicitly stated.

1. No attrition considered. Regardless of the mission or the aircraft type, no attrition is considered. This characteristic of DEPLOY was decided because, to adequately address attrition, the units would have to be matched up with specific aircraft as attrition is a function of the aircraft type and the mission being flown.

2. Airborne delivery is limited by riggers. A limiting factor of the amount of cargo delivered via air-delivery is the maximum army rigger output. It is assumed that there is no constraint on available parachutes.

3. The time span considered is four five-day periods. The time span is a set of four linked periods of five days. By reducing the number of time periods considered, the number of

VII. CONCLUSION

DEPLOY is a unique interactive user-friendly computer program that optimizes the combat power delivered to a theater during a specified time period. Further, the units deployed are kept within acceptable levels of sustainability. This final chapter is divided into two major sections. The first section will discuss a summary of the modeling process. Next, the major accomplishments of this thesis will be presented and, finally, recommendations for further research will be given.

Model Summary

This thesis was initiated after a recommendation from the thesis "Optimizing Force Development and Force Structure for the Rapid Deployment Force" completed in March 1984 by Army Captain James Cooke. Cooke demonstrated for the first time a particular methodology which determines how the interactions of unit weight, combat attributes, logistics needs, and airlift resources can be jointly optimized. (7,4) The recommendation from Cooke's thesis was to take the mathematical form of the model and develop it into a user-friendly computer package that could be used to analyze different force mixes. DEPLOY accomplished this recommendation and more. The major accomplishments of DEPLOY are discussed in the next section.

Major Accomplishments

There are three major accomplishments completed in DEPLOY. First, the mathematical model demonstrated by Cooke is developed into an interactive user-friendly computer package and, in addition to this, the user is able to perform analysis on different force mixes and different AFCD sets. Second, DEPLOY

An analysis of the output reveals many interesting results. First, the C-5 and C-141 are very heavily relied upon for all types of missions and for all sizes of cargo. Furthermore, when there is no direct delivery capability, airborne delivery is used extensively. This points out the requirement for a direct delivery type aircraft, such as the C-17. Finally, the importance of deploying fighter squadrons and ALCEs is shown in that the minimum number of both are deployed.

Summary

This chapter performed the necessary verification and demonstration of DEPLOY. The verification ensured the correctness of the model with different data sets using MPOS for an allocation routine. The demonstration showed that DEPLOY does indeed work. Here also, an example was discussed along with the meaning of the output from DEPLOY.

```
   178   ALCE          APOD  2       1.3306142
   187   ALCE-FRONT    INTRA 3        .6680929
************************************************************
0THE GOAL ACHIEVEMENTS ARE
```

PRIORITY	GOAL NUMBER	OVER-ACHIEVEMENT	UNDER-ACHIEVEMENT
2	78	.0000	2.6598
3	79	139.2600	.0000
4	80	.0000	36.2161
5	81	.0000	1.9997

The output of PAGP gives more than just the variable values. First, the subproblem or priority number on which the optimization ended is specified. This number will always be less than or equal to the number of priorities considered in the problem. One of the efficient coding techniques of PAGP discussed in Chapter IV is the use of special stopping rules. Here, the program is stopped if non-basic variables are about to enter the basis. As a result of this stopping rule, the ending subproblem may be less than the number of priorities in the problem. Second, the number of constraints, including goals, considered in the final problem is given. Next, the variable number, name and value is specified. In order to simplify the output, only the non-zero aircaft unit variables are given. The meaning of the name follows the order of the subscripts of the variable discussed in Chapter III. For aircraft variables, the type of aircraft, mission or destination, cargo type, and period of flight is specified. For unit variables, the name of the unit, mode of delivery or destination, and period of deployment is given. Finally, the attainment of the goals are specified in terms of over-achievement and under-achievement.

Table 6-6. Simulated PAGP Output.

THE OPTIMIZATION ENDED ON SUBPROBLEM 5
THERE WERE 126 CONSTRAINTS IN THE FINAL OPTIMAL TABLEAU.

****

THE OPTIMAL SOLUTION FOR THE DECISION VARIABLES X(J)

1	C-5	APOD	OUT	1	.6396083
2	C-5	APOD	OUT	2	3.6028938
3	C-5	APOD	OUT	3	3.5383696
4	C-5	APOD	OUT	4	6.7929937
5	C-5	APOD	OVER	1	4.5360120
6	C-5	APOD	OVER	2	55.9677715
9	C-5	APOD	BULK	1	1.9556843
17	C-5	APOD	PAX	1	1.1106032
21	C-5	INTRA	OUT	1	.6361074
23	C-5	INTRA	OUT	3	3.5383696
24	C-5	INTRA	OUT	4	6.7929937
27	C-5	INTRA	OVER	3	15.8438586
28	C-5	INTRA	OVER	4	26.9288448
33	C-5	INTRA	BULK	3	7.3438638
35	C-5	INTRA	BULK	4	20.8414566
42	C-5	AIREN	OUT	2	2.5010077
43	C-5	AIREN	OUT	3	.8682231
45	C-5	AIREN	OVER	1	37.8306337
46	C-5	AIREN	OVER	2	2.2263776
49	C-5	AIREN	BULK	1	17.7928981
51	C-5	AIREN	BULK	2	12.3571019
57	C-5	AIREN	PAX	1	8.1289054
58	C-5	AIREN	PAX	2	6.4454446
59	C-5	AIREN	PAX	3	.6690075
62	C-141	APOD	OVER	2	6.7172956
63	C-141	APOD	OVER	3	198.7123456
64	C-141	APOD	OVER	4	52.6629820
93	C-141	AIREN	OVER	1	246.0000000
94	C-141	AIREN	OVER	2	239.5513962
109	C-130	INTRA	OVER	1	19.2356735
111	C-130	INTRA	OVER	3	90.0000000
112	C-130	INTRA	OVER	4	90.0000000
113	C-130	INTRA	BULK	1	11.1528047
128	747C	APOD	BULK	2	7.4425366
130	747C	APOD	BULK	3	7.8594519
132	747C	APOD	BULK	4	18.5257392
136	747P	APOD	PAX	4	10.9819335
137	AREN BTLN		DIRCT	1	5.3113129
138	AREN BTLN		DIRCT	2	3.6886871
142	AREN BTLN HQ		DIRCT	2	2.2269247
143	AREN BTLN HQ		DIRCT	3	.7730753
149	AIR ASLT BTLN		INTRA	1	.2720196
151	AIR ASLT BTLN		INTRA	3	.7395374
152	AIR ASLT BTLN		INTRA	4	2.9047293
160	MECH BTLN		INTRA	4	.0000125
170	F-16 SQDN		APOD	2	2.2268286
171	F-16 SQDN		APOD	3	.7731714
177	ALCE		APOD	1	.0012929

Output Results: In this section the output of the allocation routine is given along with an explanation of the output.

Here, the process of acquiring the output data is explained. DEPLOY generated the appropriate constraints and goals from the input mentioned above. Then, the necessary information was passed to PAGP, the allocation routine, to satisfy the constraints and maximize the goals. At this point, a very unusual situation occurred. Though PAGP had been checked with a small problem in the identical format for the deployment problem, an examination of the output proved the results invalid. The output was invalid simply because the constraints were not satisfied and, therefore, the answers were infeasible. In an attempt to show that the problem could be solved, the Multi-Purpose Optimization System (MPOS) version 4.0, an LP package, was used. The method of Sequential Goal Programming (SGP) was utilized to solve the GP problem with MPOS. Here, the first goal became the objective function to maximize while lower goals were discarded. Then, the lessor of the goal or the attainment of the objective function became a new constraint, while, the second goal entered as the objective function to maximize. This iterative process continued until all the goals were considered. The results of the final ouput are listed in Table 6-6.

Table 6-3. APOD Data

1. DISTANCES

FROM US:	7200.
FROM CORPS:	200.

2. AIRCRAFT

AIRCRAFT	INTER	INTRA	OUT	OVER	BULK
C-5:	1.5	.2	1.0	1.0	1.0
C-141	1.5	.2	.0	1.0	1.0
C-130	.0	.2	.0	1.0	1.0
747P	1.5	.0	.0	1.0	1.0
747C	1.5	.0	.0	.0	.0

3. COMBAT VALUES OF UNITS CLOSING

PERIOD 1	2.5
PERIOD 2	1.8
PERIOD 3	1.3
PERIOD 4	1.1

4. MISCELLANEOUS DATA

MHE AT APOD	500
MHE AT FRT	500
ALCE CAP	600
RIGGER CAP	430.0

Table 6-4. Deployable Units Data

8 5 2 0

TYPE	NUMB	OUT	OVER	BULK	PAX	SPL	CP	AT	FT	AC	PK	TP	TV	AB	CI
AREN BTLN	9	0	1400	268	1400	149	4	19	4	0	0	0	20	1	1
AREN BTLN HQ	3	73	0	0	305	0	0	0	0	0	0	0	20	1	-1
AIR ASLT BTLN	9	152	990	574	1960	446	6	28	4	0	0	0	18	0	1
MECH BTLN	9	2055	3885	151	2052	440	8	40	6	0	0	0	14	0	1
155MM ART BTLN	3	139	1243	91	710	212	3	3	0	0	0	0	12	0	-1
F-16 SQDN	3	0	249	155	472	102	8	36	0	18	48	0	0	0	0
MDM TRUCK CMPY	3	1098	405	270	250	55	0	0	0	0	0	182	40	0	0
ALCE	2	176	2213	244	400	73	0	0	0	0	0	0	0	0	0

Table 6-5. Goals for DEPLOY

GOAL # 2 IS 25.0 OF FRONT LINE TRACE BY PERIOD 1
GOAL # 3 IS 60.0 OF ANTI-TANK POWER BY PERIOD 2
GOAL # 4 IS 180.0 OF FIREPOWER BY PERIOD 3
GOAL # 5 IS 2.0 OF MECH BTLN BY PERIOD 4

Input Parameters: The source and rationale for the different input parameters are discussed in this section. The majority of these parameters which indicate that DEPLOY works properly were the same as those used by Cooke. The airport limitations and unit weight were obtained from reference 2, along with the aircraft limitations and capabilities but were "checked and modified by HQ USAF/SAGM." As a result of this modification, the C-5 UTE Rate was changed from the 5.5 suggested by the Army, to 12.5 as suggested by the Air Force. The measure of front line trace was "taken from doctrinal publications," while the anti-tank capability was calculated "from TOE data for unit owned TOW and DRAGON weapon systems, ... using a value of 1 for TOW systems and 0.5 for DRAGON systems." The firepower for the different units was not as easily obtained. Here, the firepower "was developed from the relative firepower of units in a force-on-force war game at the Army War College." The actual data files used are given in Tables 6-2 through 6-4, while the goals are shown in Table 6-5. The goals start at the second priority, because the first priority is reserved for the inequality constraints. (7:81)

Table 6-2. Aircraft Data

5

TYPE	NMBR	AVL	DRCT	APOD	INTRA	ABRN	OUT		OVER		BULK		PAX	SPD	GTM	MHE	FP	PRK
C-5	60	.8	.0	12.5	9.0	0.0	65	25	60	25	80	25	320	430	3.3	36	1	5
C-141	190	.8	.0	12.5	10.0	12.0	0	0	21	14	25	14	110	410	2.3	13	1	12
C-130	300	.8	.0	.0	4.0	.0	0	0	14	6	14	6	64	270	1.5	6	1	16
747C	30	.8	.0	10.0	.0	.0	0	0	60	0	90	0	0	430	3.6	36	2	5
747P	20	.8	.0	10.0	.0	.0	0	0	0	0	0	0	364	430	2.8	36	2	5

Sensitivity. There are three sensitivity options in DEPLOY. These options allow the user to make specific changes to the aircraft, APOD, and deployable units data set. The changes are made one at a time, from a menu of different possibilities. Furthermore, the particular data set can be viewed after any change. To verify the editors, each option was exercised and the data viewed. In all cases, the data was correctly changed and placed in the program. Each of the sensitivity options were verified using this method. An illustration of the sensitivity portion is given in the user's guide in Appendix A.

PAGP. This is the program used to allocate the resources according to the methodology of Goal Programming. In its basic form, PAGP was designed to read inputs interactively. Therefore, since DEPLOY and PAGP are run separately, there was a requirement to pass information via files. Considering that PAGP was verified by Bunnell and Takacs in BRIK (4:77), the only verification necessary was to ensure that the proper information was properly placed. To confirm this, several write and print statements were incorporated into PAGP to check the passed data. By testing different data sets, the input parameters were visually examined as the program performed its allocation. Again, in all cases the data was correctly input. Therefore, PAGP was verified for small problems.

Demonstration

This section demonstrates the output of DEPLOY with reasonable data. There are two main areas discussed in this section, the input parameters and the allocation output.

varable is specified. If the variable is cargo aircraft, the aircraft type is given along with the type of mission or destination, cargo type and period of flight. If the variable is a deployed unit, the name is given along with its mode and time period of travel. The mode of travel of a unit is discussed in Chapter III under the variable and subscript sections. Further, if the variable is a slack or surplus variable, no name is given. An example of a constraint printout is given in Table 6-1. By using this feature, several different data sets were entered and the resulting constraints examined. In all cases, the constraint matrix correctly reflected the proper results. Therefore, the matrix formulation was verified.

Table 6-1. Constraint Output

THEATER SUPPLIES

AIJ(	33 12)=	80.00000	C-5	APOD	SUPP	2
AIJ(	33 52)=	80.00000	C-5	AIREN	SUPP	2
AIJ(	33 68)=	25.00000	C-141	APOD	SUPP	2
AIJ(	33 100)=	25.00000	C-141	AIREN	SUPP	2
AIJ(	33 129)=	90.00000	747C	APOD	SUPP	2
AIJ(	33 137)=	-745.00000	AREN BTLN		DIRCT	1
AIJ(	33 141)=	.00000	AREN BTLN HQ		DIRCT	1
AIJ(	33 145)=	-2230.00000	AIR ASLT BTLN		APOD	1
AIJ(	33 149)=	-2230.00000	AIR ASLT BTLN		INTRA	1
AIJ(	33 153)=	-2200.00000	MECH BTLN		APOD	1
AIJ(	33 157)=	-2200.00000	MECH BTLN		INTRA	1
AIJ(	33 161)=	-1060.00000	155MM ART BTLN		APOD	1
AIJ(	33 165)=	-1060.00000	155MM ART BTLN		INTRA	1
AIJ(	33 169)=	-510.00000	F-16 SQDN		APOD	1
AIJ(	33 173)=	-275.00000	MDM TRUCK CMPY		APOD	1
AIJ(	33 177)=	-365.00000	ALCE		APOD	1
AIJ(	33 181)=	-365.00000	ALCE-FRONT		APOD	1
AIJ(	33 185)=	-365.00000	ALCE-FRONT		INTRA	1
AIJ(	33 190)=	-1.00000				
AIJ(	33 189)=	1.00000				
RHS(	33)=	.00000				

VI. Verification and Demonstration

This chapter discusses the necessary verification and demonstration of DEPLOY. The verification portion of the chapter will ensure the correctness of the model through a scrutiny of the various parameters. The demonstration will show, with reasonable data, that the model accomplishes its designed purpose.

Verification

This section verifies DEPLOY by considering three critical areas. First, the correctness of the matrix formulation will be examined to ensure that it properly reflects the goals and constraints discussed in Chapter III. Next, the sensitivity portion, which changes input parameters will be tested to ensure that the desired changes are in fact made and not misplaced. Finally, the necessary input parameters for the allocation routine, PAGP, will be inspected for their proper placement.

Matrix Formulation. The matrix is comprised of the data set entered by the user and the mathematical equations discussed in Chapter III. Therefore, the model assimilates the data given by the user and develops the necessary constraints and goals. This is a noteworthy feature of DEPLOY, which helps the user examine the matrix formulation. The user has the option of observing the constraints being generated at the terminal and/or reading a hard copy of the matrix by routing the file "OFILE" to the printer. The echo of the constraint is extremely easy to read and understand. Following the title of the constraint set, the row, column and value of the variable is given. Then, the name of the

addressed first in relationship to the application and then to the usefulness of DEPLOY. Next, the input requirements for the model were examined. In the next chapter a demonstration and verification of the model will be reviewed.

EAS(I,K)	The relative ease with which cargo K can be down-loaded for aircraft I.
CPI(L)	The combat power indices for period L.
NHA	The amount of MHE in pallet equivalents prepositioned at the APOD.
NHF	The amount of MHE in pallet equivalents prepositioned at the front.
NPAL	The number of pallet equivalents the ALCE can download.
RC	The riggers' capacity to prepare airdrop loads per day.

Table 5-3
Input Requirements for the Deployable Units

UNAME(Y)	The name of the unit.
NUNT(Y)	The number of units available for deployment.
NTON(Y,K)	The equipment tonnage of size K for unit Y.
NFP(Y)	The firepower exhibited by unit Y.
NAT(Y)	The antitank force of unit Y.
NFT(Y)	The front line trace capability of unit Y.
NTAC(Y)	The number of fighter aircraft assigned to unit Y.
NPK(Y)	The number of fighters that can park at the APOD.
NTP(Y)	The ton-miles/day the unit can transport supplies.
NTV(Y)	The miles/day the unit can transport itself.
IAB(Y)	The airborne capability indicator.
NCI(Y)	The combat unit type of unit Y.

Table 5-4
Input Requirements for the Goals

ITYPE	The type of goal.
OBJ	The desired level of the goal.
IDP	The desired period to accomplish.

Conclusion

Two aspects of the model have been discussed in this chapter. The restrictions and scenario limitations were

Input Requirements

As in most models, a complete description of the entities of the model is necessary. The entities for DEPLOY are divided into four main areas; aircraft, APOD, deployable units, and goals. Each area requires specific information, and is stated in Tables 5-1 through 5-4. With this information, the different constraints and goals discussed in Chapter III are constructed. Once these constraints and goals are built, the information is fed into PAGP to optimally allocate resources for the established constraints and goals.

Table 5-1
Input Requirements for the Aircraft Inventory

ACNAME(I)	The name of the aircraft.
NAC(I)	The number of aircraft in the inventory.
AVAIL(I)	The availability of the aircraft.
UTE(I,J)	The UTE rate for a particular mission.
KARG(I,K)	The cargo carrying capability for different sizes of cargo.
KTS(I)	The cruise TAS of the aircraft.
GT(I)	The enroute ground time of the aircraft.
MHE(I)	The maximum number of pallets the aircraft can carry.
NFP(I)	The first period the aircraft is available.
NPRK(I)	The number of aircraft that can park at the APOD.

Table 5-2
Input Requirements for the APOD Complex

DUSAPD	The distance from the US to the APOD.
DAPDFT	The distance from the APOD to the front.
INTER(I)	The round trip time for an inter-theater mission for aircraft I.
INTRA(I)	The round trip time for an intra-theater mission for aircraft I.

variables and constraints are significantly reduced.

4. All units are immediately available and are located in the US. All units to be deployed are ready for deployment at the beginning of the first period. Also, the cargo and troops are considered to be in a central location.

5. A constant daily amount of supplies is necessary. In order to sustain a unit once it has deployed, only a predetermined constant amount of supplies is necessary. There is no provision for a changing supply requirement for deployed units. Furthermore, it is assumed that each unit has sufficient supplies to sustain itself until the following period.

6. Intratheater specific aircraft are not deployed at the APOD. Aircraft such as the C-130 that specialize in intratheater airlift are deployed at an area different from the APOD. If this were not the case, "the ramp and serving requirement would restrict the capability of the APOD to handle strategic airlift in the theater".(7:81)

7. The ratio of combat to combat support units is set to at least 1:1. This ratio is explained in Chapter IV under the section labeled Unit Linkage. Furthermore, this ratio can be easily changed by altering the code in subroutine CONSTR under the title Combat and Combat Support.

8. Airborne deliveries originate from the U.S. Units delivered via airdrop arrive directly from the U.S. There is no capacity to load the airborne cargo at the APOD. Also, airborne units can only be delivered via airdrop. Therefore, if there are no airdrop capable aircraft, no airborne units would be deployed.

allows the user to perform two possible types of analysis: optimal accomplishment of certain Army objectives and also determination of the minimum force structure is necessary to accomplish the goals of the Army. Finally, DEPLOY has made the model more flexible than that demonstrated by Cooke. Each of these accomplishments will be discussed in detail.

Computer Package: DEPLOY permits the user to easily define the desired force structure and APOD data. The force structure is comprised of aircraft and Army and Air Force units that may participate in the deployment. Each aircraft and unit has specific characteristics specified by the user to define the problem. Data containing the force structure and APOD data may be entered interactively or from a user-defined file. Furthermore, DEPLOY allows the user to make certain changes to the entered data, thereby saving the user the time necessary to re-enter the complete data set to make minor changes.

Types of Analysis: DEPLOY performs two types of analysis. The first type of analysis determines the degree to which the Army goals can be met with a given fleet of aircraft and deployable units. The Army goals specify levels of frontline trace, anti-tank power, and fire power. In addition, an Army goal may include the transport of a certain type of unit to the front. For instance, a goal may be to position two mechanized battalions to the front by the tenth day of battle. Each type of goal considered in the analysis is determined by the user along with the priority, level of attainment, and period of completion.

The second type of analysis determines the minimum force structure necessary to accomplish the given Army goals. Here, the Army goals become hard constraints while the aircraft become the goals to minimize. When performing this type of analysis, the user has the option to treat all aircraft types equal or to weight the aircraft according to cost or any other means. By allowing the user the option of two types of analysis, DEPLOY is more versatile in meeting the needs of the analyst.

Flexibility: By having fewer restrictions, DEPLOY is more flexible in reflecting the actual deployment of armed forces. The model used by Cooke to demonstrate his methodology had two restrictions that are not binding in DEPLOY. The two restrictions are that intratheater airlift was "limited to moving bulk cargo supplies" and ground travel time was considered equal for all deployed units. (4:80) As a result of the first restriction, the deployed units to the front had to be delivered directly to the front or delivered to the APOD and then required to transport themselves to the front. If a unit was unable to transport itself or not airborne capable and there were no direct delivery aircraft available, the unit could not be deployed. An example of a unit that is most likely unable to transport itself and is not airborne capable is an ALCE unit deployed to the front to help facilitate the incoming aircraft. DEPLOY removes this restriction and allows units to be transported to the front via intratheater airlift. The second restriction analyzed shows that all units may not be able to transport themselves at the same speed. DEPLOY allows the user to enter the distance per day that a specific unit can move and

then calculates the time required to travel from the APOD to the front. This allows the model to more accurately reflect the individual units. DEPLOY then, is more flexible in its reflection of the real deployment of troops than the model used by Cooke.

Recommendations

Research is an iterative process and, therefore, extended study would yield continued insight and practical application. DEPLOY is no exception, so that the following recommendations are made for further research:

1. Attrition of aircraft and troops should be addressed to determine the effects that it has on deployment and sustaining the units deployed.

2. A full-scale model should be analyzed with DEPLOY to determine what can be accomplished with the present day inventory of aircraft.

3. Analysis should be completed to examine Right Hand Side (RHS) ranging along with other types of sensitivity analysis.

4. PAGP should be corrected so that it can be used in conjunction with DEPLOY.

APPENDIX A

User Guide

This guide will familiarize the user with many of the features of DEPLOY. It will proceed through DEPLOY according to the various model function sequences.

DEPLOY was developed to be "user-friendly." The definition of "user-friendly" is taken to mean that anyone with the necessary data and a limited background in either computer or mathematical programming could use the model. Since DEPLOY displays prompts and menus on the screen to guide the user through the model's functions, the user needs access to a computer equipped with a monitor.

Many of the prompts which appear on the screen are questions that require answers. Realizing that a user could input an illogical response or incorrect data, the model incorporates many internal checks to guard against these possibilities. An example of a check can be found at any yes or no (1=y/0=n) question. If the user responds with something other than a 1 or 0, an error statement is issued and the user is asked to enter in a proper response. Also, the model discourages the user from inputting inappropriate data. For example, probabilities are accepted only if they are between zero and one, inclusive. Again, if the data is out of range, an error statement is given and the user is told to enter in an appropriate probability.

This user guide is divided into four main sections. The first section will discuss the process of conducting new analysis. The defining of the goals will be reviewed in the

second section. Then, in the third section, the sensitivity capability of DEPLOY will be discussed. Finally, the allocation output will be explained.

New Analysis

DEPLOY permits the user to input data interactively or through user-designated files. The input data is divided into three subsections: aircraft data, APOD data, and deployable units data. This section will describe the type of data needed by DEPLOY for new analysis.

Data is entered in the following order: aircraft, APOD and deployable units data. Since DEPLOY follows the same basic operation of input for all three data types, the following explanation applies to all three data sets. The first decision the user must make is whether the data is to be entered interactively or from a file. If there has not been any previous analysis which created a usable data base stored in a user-designated file, the data must be entered interactively. If the data is entered interactively, DEPLOY will guide the user with a series of questions. These questions insure that the required data is input in the correct format. After the data is entered, either interactively or via an external file, the user has the option to view the data set.

It is possible to build a data file independently of DEPLOY, but it is easier to input the data interactively and allow the model to build the external file. If the data base is input from an external file, the user must insure the file exists prior to operating DEPLOY. If a data file is built, its name must be less than seven characters long. Since the file must be formatted, it

is easier to allow DEPLOY to create the file.

The rest of this section describes the input requirements for the three types of data bases used in DEPLOY. Each section will list and briefly describe the required parameters of DEPLOY.

Aircraft Input: The data for the aircraft may be entered interactively or by an external file. An example of an aircraft data file is in Table A-1. The following is a list of required aircraft data:

Aircraft name	--	Maximum of 6 characters.
Number of aircraft	--	Integer, format limit = 999.
Aircraft availability	--	The percentage of aircraft in the fleet that may participate in the deployment. Real, between 0 and 1, inclusive.
Aircraft UTE rate	--	Real, between 0 and 24 hours/day, inclusive.
Cargo capacity	--	The tonnage capacity of the aircraft for out, over, and bulk sized cargo along with the number of passengers that may accompany the different cargo loads. Also, the number of passenger capacity without any cargo load. Integer, format limit = 999.
Aircraft speed	--	True Air Speed (TAS) of the aircraft in knots. Integer, format limit = 999.
Aircraft ground time	--	The ground time in hours to off-load, up-load, and refuel the aircraft at the APOD or front. Real, format limit = 99.
Pallet capacity	--	The maximum number of pallets the aircraft can carry. Integer, format limit = 999.
First period to deploy	--	The first period the aircraft will be available in the deployment. Integer, format limit = 99.

Aircraft ramp space --	The maximum number of aircraft that can park at the APOD with no other types of aircraft present. Integer, format limit = 999.

Table A-1. Example of Aircraft Data File

5

TYPE	NMBR	AVL	DRCT	APOD	INTRA	ABRN	OUT		OVER		BULK		PAX	SPD	GTM	MHE	FP	PRK
C-5	60	.8	.0	12.5	9.0	9.8	65	25	60	25	80	25	320	430	3.3	36	1	5
C-141	180	.8	.0	12.5	10.0	12.0	0	0	21	14	25	14	110	410	2.3	13	1	12
C-130	300	.8	.0	.0	4.0	.0	0	0	14	6	14	6	64	270	1.5	6	1	16
747C	30	.8	.0	10.0	.0	.0	0	0	60	0	90	0	0	430	3.6	36	2	5
747P	20	.8	.0	10.0	.0	.0	0	0	0	0	0	0	364	430	2.8	36	2	5

<u>APOD Input</u>: As in the aircraft input section, data may be entered interactively or by a user-designated file. An example of an APOD data file is given in Table A-2. The following list contains required APOD and miscellaneous parameters.

Distances --	The distance from the U.S. to the APOD and from the APOD to the front in km. Real, format limit = 99,999.
Intertheater turntimes --	The time required in days for each aircraft, from the start of one intertheater mission until the start of another intertheater mission immediately following. Real, format limit = 10.
Intratheater turntimes --	The same as intertheater turntimes, but for intratheater missions. Real, format limit = 10.
Off-loading cargo ease --	The relative ease with which a specific size of cargo for a specific aircraft can be off-loaded. Real between 0 and 1, inclusive. The default value is 1.
Combat power indices --	The time-dependent portion of firepower. Real, format limit 99.

Prepositioned MHE -- The amount of MHE measured in Pallet Equivalents (PE) prepositioned at the APOD and the front airfield. Integer, format limit = 99,999.

ALCE capability -- The number of PE's an ALCE unit can off-load in one day. Integer, format limit = 99,999.

Rigger capability -- The number of airdrop loads the Army rigger unit is able to prepare in one day. Real, format limit = 99,999.

Table A-2. Example of APOD Data File

```
1. DISTANCES
   FROM US:      7200.
   FROM CORPS:    200.
2. AIRCRAFT     INTER   INTRA   OUT    OVER   BULK
   C-5:           1.5     .2    1.0    1.0    1.0
   C-141          1.5     .2     .0    1.0    1.0
   C-130           .0     .2     .0    1.0    1.0
   747P           1.5     .0     .0    1.0    1.0
   747C           1.5     .0     .0     .0     .0
3. COMBAT VALUES OF UNITS CLOSING
   PERIOD 1       2.5
   PERIOD 2       1.8
   PERIOD 3       1.3
   PERIOD 4       1.1
4. MISCELLANEOUS DATA
   MHE AT APOD    500
   MHE AT FRT     500
   ALCE CAP       600
   RIGGER CAP   430.0
```

Deployable Units Input: As in the previous two cases, the data may be entered either interactively or via an external file. An example of a Unit Data file is given in Table A-3. The following list contains the required input data concerning the units that may be deployed.

Unit name -- Maximum of 14 characters.

Number of Units -- Integer, format limit = 99.

Equipment of Units -- The tonnage of equipment in different cargo sizes (out, over, and bulk). Integer, format limit = 99,999.

Personnel in Unit	--	The number of personnel assigned to the unit. Integer, format limit = 99,999.
Unit consumption rate	--	The consumption rate of supplies by the unit for one day. Integer, format limit = 9,999.
Firepower of Unit	--	The amount of firepower the unit displays. Real, format limit = 99.
Anti-tank power	--	The amount of anti-tank power displayed by the unit. Real, format limit = 99.
Front line trace	--	The amount of defense frontage the unit can maintain. Real, format limit = 99.
Fighter Aircraft	--	The number of fighter aircraft assigned to the unit. Real, format limit = 99.
Ramp space used	--	The maximum number of fighter aircraft only that can park at the APOD. Integer, format limit = 99.
Transport capability	--	The thousands of ton-miles/day the unit can move supplies from the APOD to the front. Integer, format limit = 99.
Unit speed	--	The distance a unit can move itself in one day without any assistance from another unit. Integer, format limit = 99.

Table A-3. Example of Unit Data File

8 5 2 0

TYPE	NUMB	OUT	OVER	BULK	PAX	SPL	FP	AT	FT	AC	PK	TP	TV	AB	CI
ARBN BTLN	9	0	1400	268	1400	149	4	19	4	0	0	0	20	1	1
ARBN BTLN HQ	3	73	0	0	305	0	0	0	0	0	0	0	20	1	-1
AIR ASLT BTLN	9	152	990	574	1960	446	6	28	4	0	0	0	18	0	1
MECH BTLN	9	2055	3885	151	2052	440	8	40	6	0	0	0	14	0	1
155MM ART BTLN	3	139	1243	91	710	212	3	3	0	0	0	0	12	0	-1
F-16 SQDN	3	0	249	155	472	102	8	36	0	18	48	0	0	0	0
MDM TRUCK CMPY	3	1098	405	270	250	55	0	0	0	0	0	182	40	0	0
ALCE	2	176	2213	244	400	73	0	0	0	0	0	0	0	0	0

DEFINING THE GOALS

DEPLOY performs two types of analysis. The first type of analysis determines the degree to which the Army goals can be met with a given fleet of aircraft and deployable units. The Army goals specify levels of frontline trace, anti-tank power, and firepower. In addition, an Army goal may include the transport of a certain type of unit to the front. For instance, a goal may be to position two mechanized battalions to the front by the tenth day of battle. The second type of analysis determines the minimum force structure necessary to accomplish the given Army goals. Here, the Army goals become hard constraints while the aircraft become the goals to minimize. The menu of the choice of analysis is given in Table A-4. When performing the second type of analysis, the user has the option of treating all aircraft equally or weighting the aircraft according to cost or any other means determined by the user.

Table A-4. Menu of the Different Types of Analysis

WHAT QUESTION DO YOU WANT ANSWERED? SELECT ONE.

---

1. FORCE STRUCTURE- USE THE LEAST NUMBER OR LEAST COSTLY AIRCRAFT TO ACCOMPLISH THE ARMY MISSION.

2. ARMY ACCOMPLISHMENT- GIVEN A FORCE STRUCTURE, ACCOMPLISH THE ARMY GOALS AS BEST AS POSSIBLE.

Once the type of analysis has been determined, the different Army goals must be defined. The user has the option of specifying levels and completion times of front line trace, anti-tank power, and firepower along with a specific type of unit. An example of the menu to define the goals is given in Table A-5.

The first priority goal is reserved for certain constraints, therefore, the user may define goals from 2 to 11, or 10 different goals. The following list contains the information necessary to define the goals:

Type of goal	--	The specified goal from the list of possible goals.
Level of the goal	--	The amount of the goal desired. Real.
Period of completion	--	The desired completion time period of the goal. Integer.

Table A-5. Menu to Define the Goals

```
SELECT THE GOAL TYPE FOR PRIORITY 2
-----------------------------------
 --  1  FRONT LINE TRACE
 --  2  ANTI-TANK POWER
 --  3  FIREPOWER
 --  4  ARBN BTLN
 --  5  ARBN BTLN HQ
 --  6  AIR ASLT BTLN
 --  7  MECH BTLN
 --  8  155MM ART BTLN
 ** IF FINISHED TYPE 0
```

After the goals have been defined, the user may view the goals that were defined. Table A-6 is an example of defined goals.

Table A-6. Example of Defined Goals.

```
GOAL # 2 IS  25.0 OF FRONT LINE TRACE BY PERIOD 1
GOAL # 3 IS  60.0 OF ANTI-TANK POWER  BY PERIOD 2
GOAL # 4 IS 180.0 OF FIREPOWER        BY PERIOD 2
GOAL # 5 IS   2.0 OF MECH BTLN        BY PERIOD 2
```

SENSITIVITY ANALYSIS

This section describes the three major sub-areas of a sensitivity analysis or changes in aircraft data, APOD data and deployed units data. To determine the data set to be altered,

the user selects the desired option from the main menu of sensitivity analysis. The main menu for the sensitivity analysis is given in Table A-7. Once the user selects the desired option, he will be asked if the data set to be altered has been input either interactively or via an external file. If the data has not been entered, the user is directed to enter the data set. Once assured that the data is in DEPLOY, a submenu is displayed from which the user directs the appropriate changes. The submenus' are given in Tables A-8 through A-10.

Table A-7. Sensitivity Analysis Main Menu

```
                    SENSITIVITY  MENU
---------------------------------------------------------
1.  AIRCRAFT DATA:
   - DELETE AN AIRCRAFT.
   - CHANGE NUMBER, AVAILABILITY, GROUND TIME.
2.  APOD DATA:
   - CHANGE DISTANCES, TURNTIMES, COMBAT VALUES.
3.  ARMY DATA:
   - DELETE A UNIT.
   - CHANGE NUMBER AVAILABLE.
   - CHANGE FIREPOWER, ANTI-TANK, FRONT LINE
        TRACE VALUES.
```

Table A-8. Aircraft Submenu

```
              AIRCRAFT CHANGE SUBMENU
---------------------------------------------------------
     1. DELETE AN AIRCRAFT.
     2. CHANGE THE NUMBER OF AIRCRAFT AVAILABLE.
     3. CHANGE THE AVAILABILITY OF AN AIRCRAFT.
     4. CHANGE THE GROUND TIME FOR AN AIRCRAFT.

REPLY 0 IF NO MORE CHANGES DESIRED
```

Table A-9. APOD Submenu

APOD CHANGE SUBMENU
1. CHANGE THE DISTANCE FROM THE US TO THE APOD.
2. CHANGE THE DISTANCE FROM THE APOD TO THE FRONT.
3. CHANGE THE COMBAT VALUES FOR THE PERIODS.
4. CHANGE THE MHE PREPOSITIONED AT THE APOD.
5. CHANGE THE MHE PREPOSITIONED AT THE FRONT.
6. CHANGE THE CAPACITY OF THE ALCE.
7. CHANGE THE CAPACITY OF THE RIGGERS.
REPLY 0 IF NO MORE CHANGES DESIRED

Table A-10. Deployable Units Submenu

ARMY CHANGE SUBMENU
1. DELETE A UNIT.
2. CHANGE THE NUMBER OF UNITS AVAILABLE.
3. CHANGE THE FIREPOWER FOR A UNIT.
4. CHANGE THE ANTI-TANK POWER FOR A UNIT.
5. CHANGE THE FRONT LINE TRACE FOR A UNIT.
REPLY 0 IF NO MORE CHANGES DESIRED

OUTPUT

The final section of this chapter will examine the output, or the allocation routine for DEPLOY. Because of the common block size limitation of ASD's CDC-750, DEPLOY and the allocation routine are two separate programs. Therefore, files are used to pass the needed information from DEPLOY to PAGP. There are three such files, TFILE, IFILE, and IDFILE. After these files are read into PAGP, and the goals are optimized, the results are written to the file GPANS. Each of these files will be discussed separately.

TFILE: this represents the "top" file, as it contains the necessary initial information for PAGP. The different input parametrs defined in TFILE are as follows:

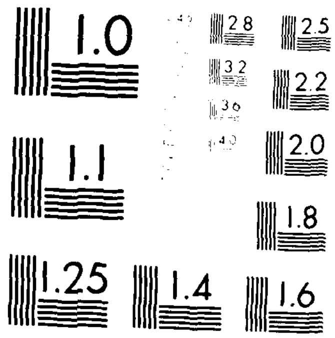
1. The number of priorities considered.
2. The number of variables.
3. The number of equality (real) constraints.
4. The total number of constraints (real and inequalities).
5. The number of named variables.
6. The number of constraints for each priority.
7. The deviational variable to be minimized.
8. The weight of the deviational variable.
9. The number of non-zero variables in each constraint and goal.

Once these parameters are read into PAGP, the coefficients of the variables are inputted.

IFILE: This corresponds to the "input" file, as it contains the values of the non-zero coefficients in the constraints and goals. It was decided early in the project to read in the non-zero terms because approximately 94% of the matrix was zero. Therefore, to correctly determine where in the matrix the non-zero coefficients should be placed, the row and column were specified. The format of the file contains two integers followed by a real number. The integers specify the row and column respectively, while the real number is the coefficient value to be placed in the matrix. As a check, the row value read in was compared to the row on which PAGP was presently operating. If the two row values were different, an error message was issued and the program aborted. Finally, by IFILE containing only the non-zero coefficients, the file creation time was reduced to one-fifth the normal creation time, and the storage space was decreased to one twelfth the normal size had all the zero and non-zero terms been included in the file. The smaller storage

AD-A152 007 DEPLOY: AN INTERACTIVE GOAL PROGRAMMING MODEL FOR THE RAPID DEPLOYMENT OF..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGI.. D O TATE 2/3

UNCLASSIFIED 06 DEC 84 AFIT/GOR/OS/84D-14 F/G 15/7 NL



MICROCOPY RESOLUTION TEST CHART

space allowed the file to be saved for future analysis.

IDFILE: This represents the "identification" file, as it identifies the variables with a specific name and meaning. By inputting the names of the variables, the output is much easier to read, as the values of the variables are matched with the name of the variable.

GPANS: The final file to be discussed is the output file which means "GP answers." Here, the subproblem or the last priority with which the optimization concluded is specified along with the number of constraints that were considered. After this, the non-zero decision variables and their values are specified. The last portion contains the achievement of the different priorities in relation to the desired achievement. An explaination of the output is given in Chapter VI along with an example of GPANS in Table 6-6.

APPENDIX B

DEPLOY Subroutine Listing

ACFINC -- Called by CHANGE and makes the desired changes in the aircraft data file.

ACINF -- Reads aircraft data from an external user-defined formatted file.

ACINS -- Allows the user to enter aircraft data interactively and save the data in a user-defined formatted file.

APDINC -- Called by CHANGE and makes the desired changes in the APOD data file.

APDINF -- Reads APOD and miscellaneous data from an external user-defined formatted file.

APDINS -- Allows the user to enter APOD-related data interactively and save the data in a user-defined formatted file.

ARMINC -- Called by CHANGE and makes the desired changes in the deployable units data file.

ARMINF -- Reads deployable units data from an external user-defined formatted file.

ARMINS -- Allows the user to enter deployable units data interactively and save the data in a user-defined formatted file.

ELDFMX -- Builds the pointer matrix from with each variable is assigned to an aircraft, unit, or a slack or surplus variable.

CONSTR -- Builds the inequality constraints from the inputted data files.

CHANGE -- Displays the possible options to alter input data, and then calls the necessary subroutine to alter the data.

FMAT -- Formats the files for PAGP.

GOALS -- Builds the goals determined in MGOAL.

HEADER -- Prints the name of the program when the program is started.

LIMITS -- Answers the following three questions:

1. What is the largest size of cargo that can be delivered directly to the front?
2. Are there any aircraft capable of airdrop?
3. Are there any airborne units?

MGOAL -- Displays the different goal options and solicits the goals from the user.

POSTC -- Called after all the changes to the data have been made in CHANGE and asks if the all the necessary data has been entered. If all the data has not been entered, the subroutine directs the user to enter the appropriate data or data files.

PRNT -- Called from CHANGE and prints on the screen the data file currently being worked on.

REALC -- Builds the equality constraints from the inputted data files.

SORTIE -- Builds the sortie constraint for the aircraft.

WRIT -- Called by CHANGE and writes the desired data file to an external file.

APPENDIX C

DEPLOY Variable Listing

Variable	Definition
AIJ(NEQ,IP)	The matrix that contains the constraints.
AVAIL(I)	The percentage of aircraft of type I that is available for the deployment.
CPI(L)	The Combat Power Index associated with period L.
DIST(N)	The distance from the US to the APOD for N=1 and from the APOD to the Front for N=2.
EAS(I,K)	The relative ease with which cargo of type K can be offloaded from aircraft type I.
FNAME	The file name.
GLS(N,J)	The matrix which contains the information about the different goals.
GT(I)	The ground time of aircraft type I.
IAB(I)	An indicator variable for airborne units.
IDFILE	The file that is created to identify the variable number with a name.
IYP	The number of units that are deployed to the front.
KARG(I,K,N)	The tonnage capacity (N=1) or passenger capacity (N=2) of type I aircraft for type K cargo.
KG	The matrix that contains the names of the different cargo types.
KTS(I)	The TAS of type I aircraft.
LL(I,N)	The lower limit of missions (N=1) or cargo type (N=2) of type I aircraft.
LMT(N)	An indicator for the largest size of cargo that can be transported via direct delivery (N=1), or an indicator variable for airborne capable aircraft (N=2) or units (N=3).

LP	The period length in days.
LPR(N)	The pointer array for the slack and surplus variables for the Rigger Constraint.
LPS(N,K,L)	A pointer matrix for the slack and surplus variables.
LPSL(L)	A pointer matrix for the slack and surplus variables.
LPU(I,M,L)	The pointer matrix for the different deployable units.
LPX(I,J,K,L)	The pointer matrix for the different aircraft types.
LU(I,N)	The upper limit of mission type (N=1) or cargo type (N=2) of type I aircraft.
MD(M)	The matrix that contains the names of the different modes of transportation.
MHE(I)	The pallet capacity of type I aircraft.
MS(J)	The matrix that contains the names of the different missions.
NAC(I)	The number of type I aircraft in the inventory.
NAME(I)	The matrix that contains the name of the different aircraft types.
NAT(I)	The amount of anti-tank power that unit type I projects.
NC(I)	The number of constraints in goal I.
NCI(I)	The combat indicator to distinguish between combat and combat support units.
NFP(I)	The amount of fire power that unit type I projects.
NCR	The number of real (equality) constraints.
NDV(NEQ)	The deviational variable to be minimized for constraint number NEQ.
NEQ	An index variable for the equations.
NFP(I)	The amount of fire power that unit type I projects.

NFT(I)	The amount of defensive frontage that type I unit can maintain.
NHA(N)	The amount of MHE prepositioned at the APOD (N=1) and at the front (N=2).
NHQ(N)	The position of the headquarter units in the unit array.
NID	The number of named variables in the file IDFILE.
NMAC	The number of different aircraft types considered in the model.
NP	The number of periods considered in the model.
NPAL	The number of pallet equivalents the ALCE unit can offload per day.
NPK(I)	The number of type I aircraft required to saturate the APOD.
NPRIT	The number of priorities in the model.
NPRK(Y)	The maximum number of fighter aircraft assigned to unit Y that can park at the APOD.
NT(NEQ)	The number of nonzero terms in equation NEQ.
NTAC(Y)	The number of fighter type aircraft assigned to unit type Y.
NTON(I,K)	The number of tons of cargo type K per unit I.
NTP(I)	The number of ton-miles per day that unit type I can transport supplies.
NTV(I)	The number of miles that unit type I can move per day.
NUNITS	The number of units considered in the model.
NUNT(I)	The number of type I units.
NWGT(NEQ)	The weight of the deviational variable for constraint NEQ.
OFILE	The output file that contains the constraints in readable form.
RC	The capability of the riggers.
RHS(NEQ)	The right hand side of constraint NEQ.

TINTER(I)	The turntime for aircraft type I on an intertheater mission.
TINTRA(I)	The turntime for aircraft type I on an intratheater mission.
UNAME(I)	The matrix that contains the names of the different units.
UTE(I,J)	The UTE rate for type I aircraft on mission type J.

APPENDIX D

```
      PROGRAM THESIS
C***********************************************************************
C**  25 NOV 85
C**   THESIS WORK BY CAPT DAVID O. TATE
C**
C***********************************************************************
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14,FNAME*6
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTB(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/TAB/NP,LP,IP,NCR,NEQ,NFRIT,LL(10,2),LU(10,2),LPK(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C*****************************   MAIN   GOES   HERE   *****************
C**  THIS FILE GIVES THE OUTPUT INTO A HARD COPY IF DESIRED
C
      FNAME='OFILE'
      OPEN(13,FILE=FNAME)
      REWIND(13)
      FNAME='IOFILE'
      OPEN(17,FILE=FNAME)
      REWIND(17)
C@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C**  CHECK TO SEE IF FAST RUN DESIRED
C
      PRINT *,'DESIRE FAST RUN? (1=Y/0=N)'
      READ *,NFAS
      IF(NFAS.EQ.1) THEN
         CALL INTIAL
         CALL ACINF
         CALL APDINF
         CALL ARMINF
      PRINT 12
         GO TO 98
      END IF
C@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C**  PRINT OUT THE HEADER
C
      CALL HEADER
      CALL INTIAL
C
C**  DISPLAY THE NUMBER OF PERIODS AND PERIOD LENGTH
C**  AND MAKE CHANGES IF NECESSARY
C
 51   PRINT 12
      PRINT *,'THERE ARE ',NP,' TIME PERIODS, ',LP,' DAYS LONG.'
```

```
      PRINT *,'DO YOU CARE TO CHANGE THE:'
      PRINT *,'      1. NUMBER OF PERIODS CONSIDERED.'
      PRINT *,'      2. LENGTH OF THE PERIOD CONSIDERED.'
      PRINT *,'      3. MAKE NO CHANGES.'
      PRINT *
      PRINT *,'  SELECT ONE OPTION.'
 52   READ *,NTIME
      IF(NTIME.LT.1.OR.NTIME.GT.3) THEN
         PRINT *,'NOT A VALID RESPONSE! SELECT (1,2,3).'
         GO TO 52
      END IF
      IF(NTIME.EQ.1) THEN
         PRINT 12
         PRINT *,'ENTER THE NUMBER OF PERIODS DESIRED.'
         READ *,NP
       END IF
       IF(NTIME.EQ.2) THEN
         PRINT 12
         PRINT *,'ENTER THE LENGTH OF THE PERIOD IN DAYS.'
         READ *,LP
       END IF
      IF(NTIME.NE.3) GO TO 50
C
C**  FIND OUT WHAT KIND OF ANALYSIS WANTS TO BE DONE
C
 50   PRINT 12
      PRINT *,'WHAT TYPE OF ANALYSIS IS THIS? SELECT ONE OPTION.'
      PRINT *,'     1)  NEW ANALYSIS.'
      PRINT *,'     2)  CONTINUATION OF AN EXISTING ANALYSIS.'
      PRINT *,'     3)  QUIT.'
 2    READ *,NRES
         IF(NRES.LT.1.OR.NRES.GT.3) THEN
            PRINT *,'NOT A VALID OPTION, PLEASE ENTER(1,2,3).'
            GO TO 2
         END IF
      IF(NRES.EQ.3) STOP
      IF(NRES.EQ.2) THEN
         CALL CHANGE
         GO TO 98
      END IF
C
C**  FIND OUT HOW THE DATA WILL BE ENTERED FOR THE AIRCRAFT FILE
C
      PRINT 12
      PRINT *,'HOW WILL YOU ENTER THE DATA FOR THE AIRCRAFT FILE?'
      PRINT *,' SELECT ONE OPTION.'
      PRINT *,'     1)  INTERACTIVELY.'
      PRINT *,'     2)  FROM A USER DEFINED FILE.'
 3    READ *,NFILE
         IF(NFILE.LT.1.OR.NFILE.GT.2) THEN
            PRINT *,'NOT A VALID OPTION, PLEASE ENTER (1,2).'
            GO TO 3
         END IF
      IF(NFILE.EQ.1) THEN
         CALL [illegible](NP
```

```
      ELSE
         CALL ACINF
      END IF
C
C**  FIND OUT HOW THE DATA WILL BE ENTERED FOR THE APOD FILE
C
      PRINT 12
      PRINT *,'HOW WILL YOU ENTER THE DATA FOR THE APOD FILE?'
      PRINT *,' SELECT ONE OPTION.'
      PRINT *,'      1)  INTERACTIVELY.'
      PRINT *,'      2)  FROM A USER DEFINED FILE.'
 10   READ *,NFILE
         IF(NFILE.LT.1.OR.NRES.GT.2) THEN
            PRINT *,'NOT A VALID OPTION, PLEASE ENTER (1,2).'
            GO TO 10
         END IF
      IF(NFILE.EQ.1) THEN
         CALL APDINS(NMAC,NP)
      ELSE
         CALL APDINF
      END IF
C
C**  FIND OUT HOW THE DATA WILL BE ENTERED FOR THE APOD FILE
C
      PRINT 12
      PRINT *,'HOW WILL YOU ENTER THE DATA FOR THE ARMY UNIT FILE?'
      PRINT *,' SELECT ONE OPTION.'
      PRINT *,'      1)  INTERACTIVELY.'
      PRINT *,'      2)  FROM A USER DEFINED FILE.'
 20   READ *,NFILE
         IF(NFILE.LT.1.OR.NRES.GT.2) THEN
            PRINT *,'NOT A VALID OPTION, PLEASE ENTER (1,2).'
            GO TO 20
         END IF
      IF(NFILE.EQ.1) THEN
         CALL ARMINS
      ELSE
         CALL ARMINF
      END IF
C
C**  CHECK TO SEE IF THERE ARE CHANGES TO BE MAKE TO THE DATA
C
 45   PRINT 12
      PRINT *,'DO YOU WISH TO MAKE ANY CHANGES TO THE ENTERED DATA?'
      PRINT *,'ENTER (1=Y,0=N).'
 25   READ *,NCHECK
      IF(NCHECK.LT.0.OR.NCHECK.GT.1) THEN
         PRINT *,'NOT A VALID RESPONSE! (1=Y/0=N).'
         GO TO 25
      END IF
      IF(NCHECK.EQ.1) GO TO 10
C
C** END OF THE INPUT, NOW THE SET UP BEGINS
C
      PRINT 12
```

```
C
C**  BUILD THE LPK & PU MATRIX- 62
C
      CALL BLDMX(NUNITS)
C
C**  BUILD THE REAL CONSTRAINTS- 63
C
       CALL REALC
C
C**  BUILD THE PRIORITY #1 CONSTRAINTS- 64
C
       CALL CONSTR(ATTR)
C
C**  ASK IF THIS IS AN FORCE STRUCTURE ANALYSIS- WHAT IS THE MINIMUM
C**  NUMBER OF AIRCRAFT REQUIRED TO PERFORM THE ARMY REQUIREMENT, OR
C**  IS IT ANY ARMY DEPLOYMENT ANALYSIS- GIVEN A CERTAIN NUMBER OF
C**  AIRCRAFT, HOW MUCH OF THE DESIRED OBJECTIVES CAN BE MET.
C
      NOW(1)=5
      PRINT 12
      PRINT *,'    WHAT QUESTION DO YOU WANT ANSWERED? SELECT ONE.'
      PRINT *,'-----------------------------------------------------'
      PRINT *,'     1.  FORCE STRUCTURE- USE THE LEAST NUMBER AND LEAST
      PRINT *,'         COSTLY AIRCRAFT TO ACCOMPLISH THE ARMY MISSION
      PRINT *
      PRINT *,'     2.  ARMY ACCOMPLISHMENT- GIVEN A FORCE STRUCTURE,
      PRINT *,'         ACCOMPLISH THE ARMY GOALS AS BEST AS POSSIBLE.'
 30   READ *,NQUES
      IF(NQUES.LT.1.OR.NQUES.GT.2) THEN
         PRINT *,'NOT A VALID REPLY! ENTER (1 OR 2).'
         GO TO 30
      END IF
      IF(NQUES.EQ.1) THEN
         PRINT 12
         PRINT *,'    HOW DO YOU WANT TO CONSIDERED THE DIFFERENT AIRCRAF
     1T
         PRINT *,'-----------------------------------------------------
     1-----
         PRINT *,'        1.  ALL EQUAL (DEFAULT).'
         PRINT *,'        2.  ACCORDING TO COSTS (USER INPUT).'
         PRINT *
         PRINT *,'CHOOSE ONE OPTION.'
 42      READ *,NCOST
         IF(NCOST.LT.1.OR.NCOST.GT.2) THEN
            PRINT *,'NOT A VALID REPLY!  ENTER (1,2).'
            GO TO 42
         END IF
C
C**  MAKE THE NUMBER OF EACH AIRCRAFT EQUAL TO ZERO
C
         DO 43 I=1,NMAC
            NAC(I)=0
 43      CONTINUE
C
C**  ASK WHAT THE COSTS ARE IF COST IS TO BE CONSIDERED
```

```
C
        IF (NCOST.EQ.1) THEN
           PRINT 12
           PRINT *,'      ENTER THE COST FOR EACH OF THE AIRCRAFT.'
           PRINT *,'-----------------------------------------------------'
           DO 44 I=1,NAC
              PRINT 5,I,NAME(I)
              READ *,COST(I+NEQ)
44         CONTINUE
5          FORMAT(5X,I2,5X,A[illegible])
        END IF
     END IF
     IF (NCLSE.EQ.1) THEN
        PRINT 12
        CALL SORTIE
        NC(1)=NEQ+NCR
     END IF
     IF(NFAS.EQ.1) THEN
        CALL MSCAL
     ELSE
           SLE(2,1)=1
           SLE(2,2)=11.33333
           SLE(2,3)=1
           SLE(3,1)=2
           SLE(3,2)=50
           SLE(3,3)=2
           SLE(4,1)=3
           SLE(4,2)=170
           SLE(4,3)=4
           SLE(5,1)=7
           SLE(5,2)=2
           SLE(5,3)=4
           NC(2)=1
           NC(3)=1
           NC(4)=1
           NC(5)=1
           NPRIT=5
     END IF
C
C**  BUILD THE SCALE
C
     DO 21 I=2,NPRIT
        ITYPE=INT(SLE(I,1))
        CEI=SLE(I,2)
        ITP=INT(SLE(I,3))
        CALL SCALE(ICP,CEI,ITYPE,I)
        NC(I)=NEQ+4
21   CONTINUE
     IF (NCLSE.EQ.1) THEN
        NPRIT=1
        NC(1)=NEQ+NCR
        CALL SORTIE
     END IF

 **  [illegible] IF THE [illegible] TO [illegible]
```

```
C
 20   PRINT *,'      SELECT ONE OF THE AIRCRAFT TO DELETE.'
      PRINT *,'-----------------------------------------------'
      DO 22 I=1,NMAC
        PRINT 5,I,NAME(I)
 22   CONTINUE
      PRINT *
      PRINT *,' 0 IF NONE.'
 24   READ *,NRES
      IF(NRES.LT.0.OR.NRES.GT.NMAC) THEN
         PRINT *,'NOT A VALID RESPONSE  ENTER AGAIN.'
         GO TO 24
      END IF
      IF(NRES.EQ.0) RETURN
C
C** MAKE ADJUSTMENTS TO THE DATA
C
      NMAC=NMAC-1
      DO 25 I=NRES,NMAC
         NAME(I)=NAME(I+1)
         NAC(I)=NAC(I+1)
         AVAIL(I)=AVAIL(I+1)
         DO 26 J=1,4
            UTE(I,J)=UTE(I+1,J)
 26      CONTINUE
         DO 27 J=1,5
            DO 28 K=1,2
               AARS(I,J,K)=AARS(I+1,J,K)
 28         CONTINUE
 27      CONTINUE
         ATE(I)=ATE(I+1)
         ST(I)=ST(I+1)
         MHE(I)=MHE(I+1)
         NFR(I)=NFR(I+1)
         NREM(I)=NREM(I+1)
 25   CONTINUE
      RETURN
C
C** CHANGE THE NUMBER OF AIRCRAFT AVAILABLE FOR THE DEPLOYMENT
C
 30   PRINT *,' SELECT THE AIRCRAFT YOU DESIRE TO INCREASE THE NUMBER'
      PRINT *,'-------------------------------------------------------'
      DO 32 I=1,NMAC
         PRINT 5,I,NAME(I),NAC(I)
 32   CONTINUE
      PRINT *
      PRINT *,' 0 IF NONE.'
 34   READ *,NRES
      IF(NRES.LT.0.OR.NRES.GT.NMAC) THEN
         PRINT *,'NOT A VALID RESPONSE  ENTER AGAIN.'
         GO TO 34
      END IF
      IF(NRES.EQ.0) RETURN
      PRINT *
      PRINT *
```

```
      END IF
      DO 44 I=1,NMAC
         WRITE(13,3)NAME(I),NAC(I),AVAIL(I),UTE(I,1),UTE(I,2),UTE(I,3),
     C     UTE(I,4),KARG(I,1,1),KARG(I,1,2),KARG(I,2,1),KARG(I,2,2),
     C     KARG(I,3,1),KARG(I,3,2),KARG(I,4,2),KTS(I),GT(I),MHE(I),
     C     NFP(I),NFRK(I)
         IF(NSAVE.EQ.1) THEN
         WRITE(15,3)NAME(I),NAC(I),AVAIL(I),UTE(I,1),UTE(I,2),UTE(I,3),
     C     UTE(I,4),KARG(I,1,1),KARG(I,1,2),KARG(I,2,1),KARG(I,2,2),
     C     KARG(I,3,1),KARG(I,3,2),KARG(I,4,2),KTS(I),GT(I),MHE(I),
     C     NFP(I),NFRK(I)
         END IF
         IF(INQ.EQ.1) THEN
           PRINT 3,NAME(I),NAC(I),AVAIL(I),UTE(I,1),UTE(I,2),UTE(I,3),
     C       UTE(I,4),KARG(I,1,1),KARG(I,1,2),KARG(I,2,1),KARG(I,2,2),
     C       KARG(I,3,1),KARG(I,3,2),KARG(I,4,2),KTS(I),GT(I),MHE(I),
     C       NFP(I),NFRK(I)
         END IF
 44   CONTINUE
      IF(NSAVE.EQ.1) CLOSE (15)
      IF(INQ.EQ.1) THEN
         PRINT *
         PRINT *,'INPUT ANY CHARACTER TO CONTINUE.'
         READ 2,FNAME
      END IF
C
C** FORMAT STATEMENTS
C
 2    FORMAT(A6)
 4    FORMAT(A7)
 6    FORMAT(' ////////////////////')
 3    FORMAT(A6,I4,5F5.1,1X,3(I3,1X,I2),I4,I4,F4.1,2(I3),I4)
C
C
      RETURN
      END
C*****************************************************************
C** 5
      SUBROUTINE ACFIND(ICHG)
C
C**  THIS WILL MAKE CHANGES AS DESIRED FROM THE CHANGE SUBROUTINE
C**  FOR THE AIRCRAFT DATA
C
      CHARACTER NAME(10)*6,CNAME(11)*14,GNAME(3)*14,FNAME,MS(4)*5,
     C   KG(5)*4,MD(3)*5
      COMMON /AIR/ NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NFRK(10)
      COMMON /CHR/ NAME,CNAME,GNAME,MS,KG,MD
C
C**  GO TO THE CORRECT STATION FOR THE CHANGE
C
      PRINT *
      GO TO (20,30,40,50) ICHG
C
C** DELETE AN AIRCRAFT FROM THE DATA LIST
```

```
          PRINT *, THERE ARE ONLY   (NR)  PERIODS CONSIDERED.
          PRINT *,  DO YOU WANT TO RE-ENTER THE FIRST PERIOD AVAILABL
     IE? (1=Y,0=N)
 30       READ *,NAME
          IF(NAME.GT.1.OR.NAME.LT.0) THEN
             PRINT *,'NOT A PROPER RESPONSE  ENTER (1=Y,0=N).'
             GO TO 30
          END IF
          IF(NAME.EQ.1) GO TO 29
        END IF
      PRINT *
      PRINT *, INPUT THE NUMBER OF AC (INTEGER) THAT CAN PARK AT THE ARI
     CD.'
      READ *,NPARK(I)
C
C** CHECK IF THE MEMORY FOR DATA CLOSE TO BEING FULL
C
      PRINT *
      IF(I.EQ.9) PRINT *,'YOU ONLY HAVE MEMORY FOR ONE MORE AIRCRAFT.'
      IF(I.EQ.10) THEN
        PRINT *,'*************************************************'
        PRINT *,'**   YOU ARE OUT OF MEMORY FOR AIRCRAFT DATA    **'
        PRINT *,'*************************************************'
        GO TO 20
      END IF
C
C**  GO BACK TO GET MORE DATA
C
      PRINT 6
      GO TO 11
C
C**  END OF THE INPUT
C
 20   NMAC=I
      IF(NSAVE.EQ.1) WRITE(15,*) NMAC
      PRINT 6
      PRINT *,'DO YOU WANT TO SEE THE INPUT FILE CREATED? (1=Y/0=N)'
 21   READ *,IYO
      IF(IYO.GT.1.OR.IYO.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).
         GO TO 21
      END IF
C
C**  WRITE OUT DATA TO THE FILE AND PRINT IF DESIRED
C
      TITLE='TYPE  NMBR  AVL ORCT APOD INTRA AERN  OUT   OVER  BULK PAX
     CSFC GTM MHE FP PRK'
      IF(IYO.EQ.1) THEN
         PRINT 6
         PRINT *,NMAC
         PRINT 4,TITLE
      END IF
      IF(NSAVE.EQ.1) THEN
         WRITE (15,*) NMAC
         WRITE (15,4) TITLE
```

```
      READ *,UTE(I,1)
      IF(UTE(I,1).LT.0.OR.UTE(I,1).GT.24) THEN
         PRINT *,'NOT A VALID UTE RATE.  (0 < UTE < 24).'
         GO TO 45
      END IF
46    PRINT *,'      INTERTHEATER TO THE APOD.'
      READ *,UTE(I,2)
      IF(UTE(I,2).LT.0.OR.UTE(I,2).GT.24) THEN
         PRINT *,'NOT A VALID UTE RATE.  (0 < UTE < 24).'
         GO TO 46
      END IF
47    PRINT *,'      INTRATHEATER TO THE FRONT.'
      READ *,UTE(I,3)
      IF(UTE(I,3).LT.0.OR.UTE(I,3).GT.24) THEN
         PRINT *,'NOT A VALID UTE RATE.  (0 < UTE < 24).'
         GO TO 47
      END IF
48    PRINT *,'      AIRDROP TO THE FRONT.'
      READ *,UTE(I,4)
      IF(UTE(I,4).LT.0.OR.UTE(I,4).GT.24) THEN
         PRINT *,'NOT A VALID UTE RATE.  (0 < UTE < 24).'
         GO TO 48
      END IF
      PRINT *
      PRINT *,'INPUT FIRST THE TONNAGE (REAL) AND THEN THE NUMBER OF PA
     C(INTEGER).'
      PRINT *,'FOR EACH TYPE OF CARGO ALONG WITH #PA.'
      PRINT *,'      OUTSIZE:'
      READ *,KARG(I,1,1),KARG(I,1,2)
      PRINT *,'      OVERSIZE:'
      READ *,KARG(I,2,1),KARG(I,2,2)
      PRINT *,'      BULK-SIZE:'
      READ *,KARG(I,3,1),KARG(I,3,2)
C
C**  BULK SAME AS SUPPLIES
C
         KARG(I,5,1)=KARG(I,3,1)
         KARG(I,5,2)=KARG(I,3,2)
      PRINT *
      PRINT *,'INPUT THE CAPACITY OF PAX ONLY (INTEGER) IN THE ',NAME(I
      READ *,KARG(I,4,2)
      PRINT *
      PRINT *,'INPUT THE AVERAGE CRUISE TAS (INTEGER) FOR THE ',NAME(I
      READ *,KTS(I)
      PRINT *
      PRINT *,'INPUT THE GROUND TIME TO UNLOAD AND REFUEL (REAL).'
      READ *,GT(I)
      PRINT *
      PRINT *,'INPUT THE NUMBER OF PALLETS (INTEGER) IN A ',NAME(I
      READ *,MHE(I)
      PRINT *
      PRINT *,'WHAT IS THE FIRST PERIOD THE AC WILL BE AVAILABLE.'
29    READ *,NFP(I)
         IF(NFP(I).GT.NP) THEN
            PRINT *,'ARE YOU SURE THAT IT IS NOT UNTIL THE '
```

```
    COR CONTINUE.'
      PRINT *,'DO YOU WANT TO CONTINUE? (1=Y,0=N)'
 10   READ *,NRES
      IF(NRES.GT.1.OR.NRES.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 10
      END IF
      IF(NRES.EQ.0) STOP
C
C**  ASK IF DESIRED TO SAVE DATA IN A FILE
C
      PRINT 6
      PRINT *,'DO YOU WANT THE DATA SAVED IN AN EXTERNAL FILE?(1=Y,0=N)'
 12   READ *,NSAVE
      IF(NSAVE.GT.1.OR.NSAVE.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 12
      END IF
      IF(NSAVE.EQ.1) THEN
         PRINT *,'ENTER THE NAME OF THE FILE YOU WANT THE DATA SAVED (6
    CCHARACTERS MAX)'
         READ 2,FNAME
       OPEN(15,FILE=FNAME)
         REWIND(15)
      END IF
C
C** START THE INPUT PROCESS
C
      I=0
      PRINT 6
      PRINT *,'I AM READY TO ACCEPT YOUR INPUTS, AND WILL PROMPT YOU FOR
    C THE DATA.'
 11   PRINT *
      PRINT *,'------------------------------------------------------'
      PRINT *,'--              ENTERING  AIRCRAFT  DATA            --'
      PRINT *,'------------------------------------------------------'
      PRINT *
      PRINT *,'INPUT THE AIRCRAFT NAME. * IF FINISHED INPUT 0.'
      READ 2,FIRST
      IF(FIRST.EQ.'0') GO TO 20
      I=I+1
      NAME(I)=FIRST
      PRINT *
      PRINT *,'INPUT THE NUMBER OF ',NAME(I),' IN THE INVENTORY.'
      READ *,NAC(I)
      PRINT *
      PRINT *,'INPUT THE AVAILABILITY (REAL) OF THE ',NAME(I),'. (0..1).'
 31   READ *,AVAIL(I)
      IF(AVAIL(I).LT.0.OR.AVAIL(I).GT.1) THEN
         PRINT *,'NOT A VALID REPLY!  (0 < AVAIL < 1).'
         GO TO 31
      END IF
      PRINT *
      PRINT *,'INPUT THE UTE RATE (REAL) FOR THE FOLLOWING MISSIONS:'
 45   PRINT *,'      DIRECT DELIVERY'.
```

```
 6     CONTINUE
       CLOSE (10)
       IF(IVU.EQ.1) THEN
          PRINT *
          PRINT *,'ENTER ANY CHARACTER TO CONTINUE.'
          READ 2,FNAME
       END IF
C
C**  FORMAT STATEMENTS
C
 2     FORMAT(A6)
 4     FORMAT(A77)
 8     FORMAT(A6,I4,5F5.1,1X,3(I3,1X,I2),I4,I4,F4.1,2(I3),I4)
 9     FORMAT(//////////////////////////)
C
C
       RETURN
       END
C***********************************************************************
C**  SS
       SUBROUTINE ACINS(NP)
C
C**  CREATES THE AIRCRAFT FILE FOR THE ANALYSIS
C
       CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14,MS(4)*5,KG(5)*4,
     C   MD(3)*5
       CHARACTER FIRST*6,FNAME*6,TITLE*77
       COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
       COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C
       PRINT 6
       PRINT *,'   THE FOLLOWING DATA IS NEEDED FOR EACH AIRCRAFT.'
       PRINT *,'----------------------------------------------------'
       PRINT *,'AIRCRAFT NAME              ---      MAX 6 CHARACTERS'
       PRINT *,'NUMBER OF AIRCRAFT         ---      < 1,000'
       PRINT *,'AVAILABILITY OF THE AC     ---      BETWEEN (0...1)'
       PRINT *,'DAILY UTE RATE FOR THE FOLLOWING MISSIONS:'
       PRINT *,'    DIRECT DELIVERY        ---      < 24.0'
       PRINT *,'    APOD DELIVERY          ---      < 24.0'
       PRINT *,'    INTRATHEATER           ---      < 24.0'
       PRINT *,'    AIRDROP                ---      < 24.0'
       PRINT *,'TONNAGE OF THE FOLLOWING CARGO ALONG WITH PAX:'
       PRINT *,'    OUTSIZE                ---      < 1,000/100'
       PRINT *,'    OVERSIZE               ---      < 1,000/100'
       PRINT *,'    BULK SIZE              ---      < 1,000/100'
       PRINT *,'CAPACITY OF PAX ONLY CARGO---       < 1,000'
       PRINT *,'TAS OF THE AIRCRAFT(KTS)   ---      < 1,000'
       PRINT *,'GROUND TIME TO UNLOAD(HRS)---       < 100.0'
       PRINT *,'MAX NUMBER OF PALLETS      ---      < 1,000'
       PRINT *,'FIRST PERIOD AC IS AVAILABLE-       < # PERIODS'
       PRINT *,'NUMBER OF AC PARK AT APOD ---       < 1,000'
       PRINT *
       PRINT *,'IF YOU DO NOT HAVE ALL THE ABOVE DATA, YOU MAY TERMINATE
```

```
C
C**   READS IN AN EXTERNAL FILE THAT CONTAINS
C**   INFORMATION ABOUT THE STRATEGIC AIRCRAFT
C
      CHARACTER NAME(10)*5,HDG*77,FNAME*6,UNAME(11)*14,GNAME(3)*14,
     C   MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**  FIND THE FILE NAME WITH THE DATA
C
      PRINT 9
      PRINT *,'ENTER THE FILE NAME (6 CHAR MAX) WITH THE AIRCRAFT DATA.'
      READ 2,FNAME
      OPEN(10,FILE=FNAME)
      REWIND(10)
C
C**  ASK IF THE FILE IS TO BE VIEWED
C
      PRINT 9
      PRINT *,'DO YOU WANT TO SEE THE INPUT FILE? (1=Y/0=N)'
 21   READ *,IVU
      IF(IVU.GT.1.OR.IVU.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 21
      END IF
C
C**  READ IN THE DATA FILE
C
 99   READ (10,*)NMAC
      READ (10,4)HDG
      WRITE (13,*)NMAC
      WRITE (13,4)HDG
      IF(IVU.EQ.1) THEN
         PRINT 9
         PRINT *,NMAC
         PRINT 4,HDG
      END IF
 5    DO 6 I=1,NMAC
         READ(10,8)NAME(I),NAC(I),AVAIL(I),UTE(I,1),UTE(I,2),UTE(I,3),
     C     UTE(I,4),KARG(I,1,1),KARG(I,1,2),KARG(I,2,1),KARG(I,2,2),
     C     KARG(I,3,1),KARG(I,3,2),KARG(I,4,2),KTS(I),GT(I),MHE(I),
     C     NFP(I),NPRK(I)
         KARG(I,5,1)=KARG(I,3,1)
         KARG(I,5,2)=KARG(I,3,2)
         WRITE(13,8)NAME(I),NAC(I),AVAIL(I),UTE(I,1),UTE(I,2),UTE(I,3),
     C     UTE(I,4),KARG(I,1,1),KARG(I,1,2),KARG(I,2,1),KARG(I,2,2),
     C     KARG(I,3,1),KARG(I,3,2),KARG(I,4,2),KTS(I),GT(I),MHE(I),
     C     NFP(I),NPRK(I)
         IF(IVU.EQ.0) GO TO 6
         PRINT 8,NAME(I),NAC(I),AVAIL(I),UTE(I,1),UTE(I,2),UTE(I,3),
     C     UTE(I,4),KARG(I,1,1),KARG(I,1,2),KARG(I,2,1),KARG(I,2,2),
     C     KARG(I,3,1),KARG(I,3,2),KARG(I,4,2),KTS(I),GT(I),MHE(I),
     C     NFP(I),NPRK(I)
```

```
         WRITE(13,81)I,IP,LPR(I)
         IF(LANS.EQ.0) GO TO 80
         PRINT 81,I,IP,LPR(I)
 80   CONTINUE
 81   FORMAT('LPR(',I2,')=',2I6)
      WRITE(13,*)'IP=',IP
      CLOSE(17)
      RETURN
      END
C*********************************************************************
C S11
      SUBROUTINE LIMITS
C
C  THIS DETERMINES THE LIMITS OF
C     LMT(1): LARGEST TYPE OF CARGO THAT A DIRECT DELIVERY AC
C             CAN DELIVER
C     LMT(2): 1 IF THERE ARE ANY AIRDROP CAPABLE AC, ELSE=0
C     LMT(3): 1 IF THERE ARE ANY AIRBORNE UNITS, ELSE=0
C
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
C
      ID=0
      DO 10 I=1,NMAC
         IF(LL(I,1).GT.1) GO TO 12
            IF(ID.EQ.0) THEN
               ID=I
               LMT(1)=LL(I,2)
               GO TO 12
            END IF
         IF(LL(I,2).LT.LL(ID,2)) THEN
            ID=I
            LMT(1)=LL(I,2)
         END IF
 12      IF(LU(I,1).EQ.4) LMT(2)=1
 10   CONTINUE
C
      DO 20 I=1,NUNITS
         IF(IAB(I).EQ.0) GO TO 20
         LMT(3)=1
 20   CONTINUE
C
      WRITE(13,22)LMT(1),LMT(2),LMT(3)
 22   FORMAT('LMT(I)=',3I3)
C
      RETURN
      END
C*********************************************************************
C**  S2
      SUBROUTINE ACINF
```

```
            DO 60 N=1,NP
                  IP=IP+1
                  LPU(I,M,N)=IP
                  WRITE(13,62)LPU(I,M,N),UNAME(I),MD(M),N
                  WRITE(17,62)LPU(I,M,N),UNAME(I),MD(M),N
                  IF(LANS.EQ.0) GO TO 60
                  PRINT 62,LPU(I,M,N),UNAME(I),MD(M),N
 60         CONTINUE
 58      CONTINUE
 56   CONTINUE
 62   FORMAT(I4,3X,A14,2X,A5,I3)
      NID=IP
C
C**  BUILD THE LPS-MATRIX
C
C**  FOR THE SHIPMENTS- DIRCT,APOD,ABN
C**  FOR THE SUPPLIES(K=5)-THTR,FRONT,APOD
      DO 64 I=1,3
C**  FOR OUT, OVER, BULK, PAX, & SUPPLIES
         DO 65 K=1,5
C
C**  DO NOT INCLUDE (1..4) IF NO DIRECT DELIVERY NOR AIRDROP CAPABILITY
C
         IF(K.NE.5) THEN
            IF(LMT(1).LT.1.AND.I.EQ.1) GO TO 65
            IF(LMT(2).EQ.0.AND.I.EQ.3) GO TO 65
         END IF
C**  FOR EACH PERIOD
            DO 66 N=1,NP
               IP=IP+1
               LPS(I,K,N)=IP
               WRITE(13,67)I,K,N,IP,LPS(I,K,N)
               IF(LANS.EQ.0) GO TO 66
               PRINT 67,I,K,N,IP,LPS(I,K,N)
 66         CONTINUE
 65      CONTINUE
 64   CONTINUE
 67   FORMAT('LPS(',3I2,')=',2I6)
C
C**  BUILD THE LPSL-MATRIX
C
      DO 70 I=1,NP
         IP=IP+1
         LPSL(I)=IP
         WRITE(13,71)I,IP,LPSL(I)
         IF(LANS.EQ.0) GO TO 70
         PRINT 71,I,IP,LPSL(I)
 70   CONTINUE
 71   FORMAT('LPSL(',I2,')=',2I6)
C
C**  BUILD THE LPR-MATRIX, FOR RIGGER SLACK & SURPLUS
C
      DO 80 I=1,NP
         IP=IP+1
         LPR(I)=IP
```

```
      IP=0
C**  FOR EACH TYPE OF AIRCRAFT
      DO 42 I=1,NMAC
C**  FOR EACH TYPE OF MISSION DELIVERED TO:
C**  1=DRCT, 2=APOD, 3=INTRA 4=ABRN
          DO 43 J=LL(I,1),LU(I,1)
C**  FOR EACH TYPE OF CARGO:
C**  1=OUT, 2=OVER, 3=BULK,SUPPLIES, 4=PAX
              DO 44 K=LL(I,2),LU(I,2)
C**  FOR EACH AVAILABLE PERIOD
                  DO 45 L=NFP(I),NP
                      IP=IP+1
                      LPX(I,J,K,L)=IP
                      WRITE(13,17)LPX(I,J,K,L),NAME(I),MS(J),KG(K),L
                      WRITE(17,17)LPX(I,J,K,L),NAME(I),MS(J),KG(K),L
                      IF(LANS.EQ.0) GO TO 46
                      PRINT 17,LPX(I,J,K,L),NAME(I),MS(J),KG(K),L
 46                   IF(K.EQ.3) THEN
                          IP=IP+1
                          LPX(I,J,5,L)=IP
                      ELSE
                          GO TO 45
                      END IF
                      WRITE(13,17)LPX(I,J,5,L),NAME(I),MS(J),KG(5),L
                      WRITE(17,17)LPX(I,J,5,L),NAME(I),MS(J),KG(5),L
                      IF(LANS.EQ.0) GO TO 45
                      PRINT 17,LPX(I,J,5,L),NAME(I),MS(J),KG(5),L
 17                   FORMAT(I4,3X,A6,2X,A5,2X,A4,I3)
 45               CONTINUE
 44           CONTINUE
 43       CONTINUE
 42   CONTINUE
C
C**  BUILD THE LPU-MATRIX
C
C**  FOR EACH UNIT
C
      DO 56 I=1,NUNITS+1
C
C**  MODE OF DELIVERY: 1=FRONT, 2= APOD-FRONT WALK, AND 3=APOD-FLY
C
          DO 58 M=1,3
C
C**  ELIMINATE UNITS THAT REMAIN AT THE APOD FOR M=1.3
C**              DIRECT DELIVERY (M=1) IF NO DIRECT DELIVERY TYPE AC
C**              AIRDROP (M=1) IF NO ABN UNITS, OR AIRDROP TYPE AC
C**  ALSO- ABN UNITS ARE DEPLOYED ONLY BY AIRDROP
C
              IF(I.GT.IYF.AND.M.NE.3.AND.I.LE.NUNITS) GO TO 58
              IF(M.NE.1.AND.IAB(I).EQ.1) GO TO 58
              IF(LMT(1).LT.1.AND.IAB(I).EQ.0.AND.M.EQ.1) GO TO 58
              IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 58
              IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 58
              IF(IAB(I).EQ.1.AND.M.NE.1) GO TO 58
C**  FOR EACH PERIOD
```

```
 22      CONTINUE
C**  FIND THE UPPER LIMIT
        IF (UTE(I,4).NE.0.0) GO TO 24
        IF (UTE(I,3).NE.0.0) THEN
                  LU(I,1)=3
                  GO TO 24
             END IF
        IF (UTE(I,2).NE.0.0) THEN
                  LU(I,1)=2
                  GO TO 24
             END IF
        LU(I,1)=1
 24    CONTINUE
       IF (LL(I,1).LE.LU(I,1)) GO TO 26
         PRINT *,'ERROR IN LL AND LU (I,1).'
C**  FOR 2=KARGO
C**  FIND THE LOWER LIMIT
 26      LL(I,2)=1
         LU(I,2)=4
         IF (KARG(I,1,1).NE.0.0) GO TO 29
         IF (KARG(I,2,1).NE.0.0) THEN
                  LL(I,2)=2
                  GO TO 29
             END IF
         IF (KARG(I,3,1).NE.0.0) THEN
                  LL(I,2)=3
                  GO TO 29
             END IF
                    LL(I,2)=4
                    LU(I,2)=4
                    GO TO 30
 29      CONTINUE
C**  FIND THE UPPER LIMIT
         IF (KARG(I,4,2).NE.0.0) GO TO 30
         IF (KARG(I,3,1).NE.0.0) THEN
                  LU(I,2)=3
                  GO TO 30
             END IF
         IF (KARG(I,2,1).NE.0.0) THEN
                  LU(I,2)=2
                  GO TO 30
             END IF
                  LU(I,2)=1
 30    CONTINUE
C**  CHECK THE LIMITS
       IF (LL(I,2).LE.LU(I,2)) GO TO 20
         PRINT *,'ERROR IN LL AND LU (I,2).'
 20    CONTINUE
C
C**  FIND THE LIMITS
C
       CALL LIMITS
C
C**  BUILD THE LPX-MATRIX
C
```

```
C
      MS(1)='DIRCT'
      MS(2)='APOD'
      MS(3)='INTRA'
      MS(4)='AIRBN'
      KG(1)='OUT'
      KG(2)='OVER'
      KG(3)='BULK'
      KG(4)='PAX'
      KG(5)='SUPP'
      MD(1)='DIRCT'
      MD(2)='APOD'
      MD(3)='INTRA'
      RETURN
      END
C*********************************************************************
C** S-BLD
      SUBROUTINE BLDPMX
C
C**  THIS BUILDS THE POINTER MATRIX
C
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTE(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTCN(11,5),NFP(10),NAT(10),NFT(10),
     C   NTHC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C**  ASK IF POINTER IS TO BE ECHOED
*     PRINT *,'ECHO THE POINTER?(Y=1,N=0)'
*     READ *,LANS
      LANS=0
C**  FIND THE DIFFERENT AIRCRAFT LOWER AND UPPER LIMITS
      DO 20 I=1,NMAC
C**  FOR 1=MISSION
          LL(I,1)=1
          LU(I,1)=4
C**  FIND THE LOWER LIMIT
          IF (UTE(I,1).NE.0.0) GO TO 22
          IF (UTE(I,2).NE.0.0) THEN
                  LL(I,1)=2
                  GO TO 22
              END IF
          IF (UTE(I,3).NE.0.0) THEN
                    LL(I,1)=3
                    GO TO 22
              END IF
           LL(I,1)=4
           LU(I,1)=4
           GO TO 24
```

```
 24         CONTINUE
            RHS(I)=0.0
            NT(I)=0
            NDV(I)=3
            NWGT(I)=1
 22      CONTINUE
C**   ZEROIZE THE KARG AND TON MATRICES
         DO 30 I=1,10
            DO 32 J=1,5
               NTON(I,J)=0
               DO 33 K=1,2
                  KARG(I,J,K)=0
 33            CONTINUE
 32         CONTINUE
            DO 34 J=1,4
               DO 36 M=1,3
                  LPU(I,M,J)=0
 36            CONTINUE
               UTE(I,J)=0.0
               DO 38 K=1,4
                  DO 40 L=1,4
                     LPK(I,J,K,L)=0
 40               CONTINUE
 38            CONTINUE
 34         CONTINUE
            NAC(I)=0
            KTS(I)=0
            MHE(I)=0
            NFP(I)=0
            NPRK(I)=0
            AVAIL(I)=0.0
            GT(I)=0.0
            TINTER(I)=0.0
            TINTRA(I)=0.0
            NUNT(I)=0
            NTAC(I)=0
            NPK(I)=0
            NFP(I)=0
            NAT(I)=0
            NFT(I)=0
            NTP(I)=0
            NTV(I)=0
            NCI(I)=0
            IAB(I)=0
            NC(I)=1
            NHQ(1)=0
            NHQ(2)=0
 30      CONTINUE
         DO 42 I=1,9
            DO 44 J=1,3
               GLS(I,J)=0.0
 44         CONTINUE
 42      CONTINUE
C
C**   ESTABLISH THE NAMES OF THE DIFFERENT MISSIONS, KARGO, AND MODES
```

```
C
      PRINT *,'BUILD THE FILES FOR P-GP?(1=Y,0=N)'
      READ *,LANS
      IF(LANS.EQ.0) GO TO 99
C**  BUILD THE FILES FOR PAGP INPUT- 311
      CALL FMAT
 12   FORMAT(///////////////////////////////)
 99   END
C^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
C***********************************************************************
C**  S0
      SUBROUTINE INTIAL
C
C**   INITIALIZES THE PARAMETERS AND MATRICES
C
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTHC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C----------------------------
C**  INITIALIZE THE TERMS
C**  NORMAL PARAMETERS
      NP=4
      LP=5
      NPRIT=1
      DO 10 I=1,10
         DO 12 K=1,4
            EAS(I,K)=1.0
 12      CONTINUE
 10   CONTINUE
C**  ZEROIZE THE INTEGERS
      NMAC=0
      NUNITS=0
      IP=0
      NEQ=0
      NCR=0
      IYP=0
      NHA(1)=0
      NHA(2)=0
      NPAL=0
      DO 18 I=1,3
         LMT(I)=0
 18   CONTINUE
C**  ZEROIZE THE AIJ AND RHS-MATRIX
      DO 22 I=1,150
         DO 24 J=1,300
            AIJ(I,J)=0.0
```

```
      PRINT *,'ENTER THE DESIRED NUMBER OF ',NAME(NRES)
      READ *,NAC(NRES)
      RETURN
C
C** CHANGE THE AVAILABILITY OF AN AIRCRAFT
C
 40   PRINT *,'SELECT THE AIRCRAFT YOU DESIRE TO CHANGE THE AVAILABLITY
     1 OF.'
      PRINT *,'-----------------------------------------------------
     1----'
      DO 42 I=1,NMAC
         PRINT 7,I,NAME(I),AVAIL(I)
 42   CONTINUE
      PRINT *
      PRINT *,'0 IF NONE.'
 44   READ *,NRES
      IF(NRES.LT.0.OR.NRES.GT.NMAC) THEN
         PRINT *,'NOT A VALID RESPONSE! ENTER AGAIN.'
         GO TO 44
      END IF
      IF(NRES.EQ.0) RETURN
      PRINT *
      PRINT *
      PRINT *,'ENTER THE DESIRED AVAILABILITY (0..1) OF THE ',NAME(NRES)
 46   READ *,RES
      IF(RES.LT.0.OR.RES.GT.1) THEN
         PRINT *,'NOT A VALID RESPONSE! ENTER AGAIN (0..1).'
         GO TO 46
      END IF
      AVAIL(NRES)=RES
      RETURN
C
C** CHANGE THE GROUND TIME OF AN AIRCRAFT
C
 50   PRINT *,'SELECT THE AIRCRAFT YOU DESIRE TO CHANGE THE GROUND TIME'
      PRINT *,'-------------------------------------------------------'
      DO 52 I=1,NMAC
         PRINT 7,I,NAME(I),GT(I)
 52   CONTINUE
      PRINT *
      PRINT *,'0 IF NONE.'
 54   READ *,NRES
      IF(NRES.LT.0.OR.NRES.GT.NMAC) THEN
         PRINT *,'NOT A VALID RESPONSE! ENTER AGAIN.'
         GO TO 54
      END IF
      IF(NRES.EQ.0) RETURN
      PRINT *
      PRINT *
      PRINT *,'ENTER THE DESIRED GROUND TIME OF THE ',NAME(NRES)
      READ *,GT(NRES)
      RETURN
C
C** FORMAT STATEMENT
C
```

```
 5     FORMAT('           ',I2,') ',A6)
 6     FORMAT('           ',I2,') ',A6,' - ',I3)
 7     FORMAT('           ',I2,') ',A6,' - ',F3.1)
 9     FORMAT(//////////////////////////////)
C
C
       END
C*************************************************************************
C**  S4
       SUBROUTINE APDINF
C
C**    READS IN AN EXTERNAL FILE THAT CONTAINS
C**    INFORMATION ABOUT THE STRATEGIC AIRCRAFT
C
       CHARACTER HDG(4)*77,SUBH(20)*14,FNAME*6
       CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14
       CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
       COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
       COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
       COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHG(2)
       COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
       COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**  FIND THE FILE NAME WITH THE DATA
C
       PRINT 9
       PRINT *,'ENTER THE FILE NAME (6 CHAR MAX) WITH THE APOD DATA.'
       READ 2,FNAME
       OPEN(11,FILE=FNAME)
       REWIND(11)
C
C**  ASK IF THE FILE IS TO BE VIEWED
C
       PRINT 9
       PRINT *,'DO YOU WANT TO SEE THE INPUT FILE? (1=Y/0=N)'
 21    READ *,IVU
       IF(IVU.GT.1.OR.IVU.LT.0) THEN
          PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
          GO TO 21
       END IF
C
C**  READ IN THE DATA FILE BEGINNING WITH THE FIRST MAJOR HEADING
C**    AND PRINT IF TO BE VIEWED
C
 99    READ (11,4)HDG(1)
       WRITE 13,4 HDG(1)
       IF (IVU.EQ.1) THEN
          PRINT 9
          PRINT 4,HDG(1)
       END IF
```

```
C
C**  READ IN THE DISTANCES
C
      DO 12 I=1,2
         READ(11,6)SUBH(I),DIST(I)
         WRITE(13,6)SUBH(I),DIST(I)
         IF(IVU.EQ.1) PRINT 6,SUBH(I),DIST(I)
 12   CONTINUE
C
C**  READ IN THE INTER AND INTRA TURN-TIMES
C
      READ(11,4)HDG(2)
      WRITE(13,4)HDG(2)
      IF(IVU.EQ.1) PRINT 4,HDG(2)
      DO 14 I=1,NMAC
           READ(11,8)SUBH(I+2),TINTER(I),TINTRA(I),
     C      EAS(I,1),EAS(I,2),EAS(I,3)
           WRITE(13,8)SUBH(I+2),TINTER(I),TINTRA(I),
     C      EAS(I,1),EAS(I,2),EAS(I,3)
           IF(IVU.EQ.1) PRINT 8,SUBH(I+2),TINTER(I),TINTRA(I),
     C      EAS(I,1),EAS(I,2),EAS(I,3)
 14   CONTINUE
C
C**  READ IN THE COMBAT POWER INDEXES FOR UNITS CLOSING AT THE FRONT
C
      READ(11,4)HDG(3)
      WRITE(13,4)HDG(3)
      IF(IVU.EQ.1) PRINT 4,HDG(3)
      J=NMAC+2
      DO 16 I=1,NP
         READ(11,17)SUBH(I+J),CPI(I)
         WRITE(13,17)SUBH(I+J),CPI(I)
         IF(IVU.EQ.1) PRINT 17,SUBH(I+J),CPI(I)
 16   CONTINUE
C
C**  NUMBER OF MHE PREPOSITIONED
C
      READ(11,4)HDG(4)
      WRITE(13,4)HDG(4)
      IF(IVU.EQ.1) PRINT 4,HDG(4)
      J=NMAC+NP+2
      DO 18 I=1,2
         READ(11,19)SUBH(I+J),NHA(I)
         WRITE(13,19)SUBH(I+J),NHA(I)
         IF(IVU.EQ.1) PRINT 19,SUBH(I+J),NHA(I)
 18   CONTINUE
C
C**  THE NUMBER OF PALLETS AN ALCE UNIT CAN DOWNLOAD
C
      READ(11,19)SUBH(19),NPAL
      WRITE(13,19)SUBH(19),NPAL
         IF(IVU.EQ.1) PRINT 19,SUBH(19),NPAL
C
C**  RIGGER CAPABILITY PER DAY DETERMINED
C
```

```
      READ(11,17)SUBH(20),RC
      WRITE(13,17)SUBH(20),RC
         IF(IVU.EQ.1) THEN
            PRINT 17,SUBH(20),RC
            PRINT *
            PRINT *,'ENTER ANY CHARACTER TO CONTINUE.'
            READ 2,FNAME
        END IF
C
C**  FORMAT STATEMENTS
C
 2     FORMAT(A6)
 4     FORMAT(A77)
 6     FORMAT(A14,F6.0)
 8     FORMAT(A14,5F6.1)
 9     FORMAT(////////////////////////)
 17    FORMAT(A14,F6.1)
 19    FORMAT(A14,I6)
C
C
       RETURN
       END
C**********************************************************************
C** 5
       SUBROUTINE APDINS(NMAC,NF)
C
C**    PROMPTS INFORMATION FROM THE USER CONCERNING THE APOD
C**    AND MISCELLANEOUS DATA
C
       CHARACTER HDG(4)*77,SUBH(20)*14,FNAME*6
       CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14
       CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
       COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CFI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
       COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**  PRINT OUT THE INFORMATION NEEDED FOR THIS FILE
C
       PRINT 5
       PRINT *,'       THE FOLLOWING DATA IS NEEDED FOR THIS FILE:'
       PRINT *,'--------------------------------------------------------'
       PRINT *,'DISTANCES IN KM FROM'
       PRINT *,'    US TO APOD                            ---   < 100,000'
       PRINT *,'    APOD TO FRONT                         ---   < 100,000'
       PRINT *,'COMPLETION TIME (ROUND TRIP) FOR EACH AC ON:'
       PRINT *,'   INTERTHEATER MISSIONS                  ---   < 10.0'
       PRINT *,'   INTRATHEATER MISSIONS                  ---   < 10.0'
       PRINT *,'COMBAT VALUES FOR CLOSING UNITS FOR EACH PERIOD'
       PRINT *,'                                          ---   < 100.0'
       PRINT *,'THE AMOUNT OF MHE PREPOSITIONED AT:'
       PRINT *,'   APOD IN PALLET EQUIVALENTS (PE)        ---   < 100,000'
       PRINT *,'   FRONT IN PE                            ---   < 100,000'
       PRINT *,'ALCE CAPABILITY/DAY IN PE                 ---   < 100,000'
       PRINT *,'RIGGER CAPABILITY TO PREPARE AIRDROP      ---   < 100,000'
       PRINT *
```

```
      PRINT *,'IF YOU DO NOT HAVE ALL THE NEEDED DATA, YOU MAY TERMINATE
     COR CONTINUE.'
      PRINT *,'DO YOU WANT TO CONTINUE? (1=Y,0=N)'
 10   READ *,NRES
      IF(NRES.GT.1.OR.NRES.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 10
      END IF
      IF(NRES.EQ.0) STOP
C
C**  ASK IF DESIRED TO SAVE DATA IN A FILE
C
      PRINT 5
      PRINT *,'DO YOU WANT THE DATA SAVED IN AN EXTERNAL FILE?(1=Y,0=N)'
 12   READ *,NSAVE
      IF(NSAVE.GT.1.OR.NSAVE.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 12
      END IF
      IF(NSAVE.EQ.1) THEN
         PRINT *,'ENTER THE NAME OF THE FILE YOU WANT THE DATA SAVED (6
     CCHARACTERS MAX)'
         READ 2,FNAME
         OPEN(11,FILE=FNAME)
         REWIND(11)
      END IF
C
C** START THE INPUT PROCESS
C
      I=0
      PRINT 5
      PRINT *,'I AM READY TO ACCEPT YOUR INPUTS, AND WILL PROMPT YOU FOR
     C THE DATA.'
      PRINT *
      PRINT *,'-----------------------------------------------------------'
      PRINT *,'--                ENTERING   THE   APOD   DATA            --'
      PRINT *,'-----------------------------------------------------------'
      PRINT *
      PRINT *,'ENTER THE DISTANCE (KM,INTEGER) FROM US TO THE APOD.'
      READ *,DIST(1)
      PRINT *
      PRINT *,'ENTER THE DISTANCE (INTEGER) FROM APOD TO FRONT.'
      READ *,DIST(2)
      PRINT *
      PRINT *,'ENTER THE TIME (DAYS) BETWEEN MISSIONS (REAL) FOR:'
      DO 15 I=1,NMAC
         PRINT *,'        INTERTHEATER FOR THE ',NAME(I)
         READ *,TINTER(I)
         PRINT *,'        INTRATHEATER FOR THE ',NAME(I)
         READ *,TINTRA(I)
 15   CONTINUE
C
C**  INPUT THE EASE WITH WHICH DIFFERENT TYPES OF
C**  CARGO AND AIRCRAFT CAN BE UNLOADED
C
```

```
      PRINT *
      PRINT *,'WANT TO CONSIDER THAT DIFFERENT CARGO FOR DIFFERENT
      PRINT *,'  AIRCRAFT MAY BE EASIER TO OFFLOAD? (1=Y/0=N).'
 16   READ *,NEAS
      IF(NEAS.LT.0.OR.NEAS.GT.1) THEN
         PRINT *,'NOT A VALID ANSWER!  PLEASE ENTER (1=Y/0=N).'
         GO TO 16
         END IF
      IF(NEAS.EQ.0) GO TO 11
C
      PRINT *
      PRINT *,'****   NOTE:  '
      PRINT *,'     1.  THE NUMBER MUST BE BETWEEN 0 AND 1.'
      PRINT *,'     2.  A NUMBER MUST BE INPUT REGARDLESS IF THE AC IS CA
     1PABLE OF'
      PRINT *,'         CARRYING THE CARGO SIZE OR NOT.'
      PRINT *
C
      DO 13 I=1,NMAC
         PRINT *,'FOR THE ',NAME(I),' WHAT IS THE RELATIVE EASE FOR'
         PRINT *,'  OUT,OVER AND BULK CARGO?'
 14      READ *,(EAS(I,J),J=1,3)
         DO 18 J=1,3
            IF(EAS(I,J).LT.0.OR.EAS(I,J).GT.1) THEN
              PRINT *,'NOT A VALID RESPONSE! PLEASE ENTER (0...1).'
              GO TO 14
              END IF
 18      CONTINUE
 13   CONTINUE
 11   CONTINUE
      PRINT *
      PRINT *,'ENTER THE COMBAT VALUE INDEXES (REAL) FOR:'
      DO 20 I=1,NP
         PRINT *,'       PERIOD # ',I
         READ *,CPI(I)
 20   CONTINUE
      PRINT *
      PRINT *,'ENTER THE MHE (FE) PREPOSITIONED (INTEGER) AT THE:'
      PRINT *,'         APOD:'
      READ *,NHA(1)
      PRINT *,'         FRONT:'
      READ *,NHA(2)
      PRINT *
      PRINT *,'ENTER THE NUMBER OF FE/DAY (INTEGER) OF THE ALCE:'
      READ *,NPAL
      PRINT *
      PRINT *,'ENTER THE NUMBER OF LOADS/DAY (REAL) OF THE RIGGERS:'
      READ *,RC
      PRINT 5
C
C**  ASK IF THE FILE IS TO BE VIEWED
C
      PRINT *,'DO YOU WANT TO SEE THE INPUT FILE? (1=Y/0=N)'
 21   READ *,IVU
      IF(IVU.GT.1.OR.IVU.LT.0) THEN
```

```
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N)'.
         GO TO 21
      END IF
      IF(NSAVE.EQ.0.AND.IVU.EQ.0) RETURN
C
C**  SET UP THE HEADINGS FOR THE VIEW AND/OR THE FILE
C
      HDG(1)='1. DISTANCES'
      HDG(2)='2. AIRCRAFT     INTER  INTRA  OUT  OVER  BULK'
      HDG(3)='3. COMBAT VALUES OF UNITS CLOSING'
      HDG(4)='4. MISCELLANEOUS DATA'
C
C**  SET UP THE SUBHEADINGS UNLESS NSAVE=0 AND IVU=0
C
      SUBH(1)='    FROM US:'
      SUBH(2)='    FROM CORPS:'
      SUBH(3)='    PERIOD 1'
      SUBH(4)='    PERIOD 2'
      SUBH(5)='    PERIOD 3'
      SUBH(6)='    PERIOD 4'
      SUBH(17)='    MHE AT APOD'
      SUBH(18)='    MHE AT FRNT'
      SUBH(19)='    ALCE CAP'
      SUBH(20)='    RIGGER CAP'
C
C**  WRITE THE FILE TO OUTPUT
C
         WRITE (13,4)HDG(1)
         WRITE(13,6)SUBH(1),DIST(1)
         WRITE(13,6)SUBH(2),DIST(2)
         WRITE(13,4)HDG(2)
         DO 44 I=1,NMAC
            WRITE(13,8)NAME(I),TINTER(I),TINTRA(I),
     C          EAS(I,1),EAS(I,2),EAS(I,3)
 44      CONTINUE
         WRITE(13,4)HDG(3)
         DO 46 I=1,NF
            WRITE(13,1?)SUBH(I+2),I,CPI(I)
 46      CONTINUE
         WRITE(13,4)HDG(4)
         DO 48 I=1,2
            WRITE(13,19)SUBH(I+16),NHA(I)
 48      CONTINUE
         WRITE(13,19)SUBH(19),NPAL
         WRITE(13,7)SUBH(20),RC
C
C**  WRITE THE FILE IF NSAVE=1
C
      IF(NSAVE.EQ.1) THEN
         WRITE (11,4)HDG(1)
         WRITE(11,6)SUBH(1),DIST(1)
         WRITE(11,6)SUBH(2),DIST(2
         WRITE(11,4)HDG(2)
         DO 24 I=1,NMAC
            WRITE(11,8)NAME(I),TINTER(I),TINTRA(I),
```

```
     C         EAS(I,1),EAS(I,2),EAS(I,3)
 24       CONTINUE
          WRITE(11,4)HDG(3)
          DO 26 I=1,NP
             WRITE(11,17)SUBH(I+2),I,CPI(I)
 26       CONTINUE
          WRITE(11,4)HDG(4)
          DO 28 I=1,2
             WRITE(11,19)SUBH(I+16),NHA(I)
 28       CONTINUE
          WRITE(11,19)SUBH(19),NPAL
          WRITE(11,7)SUBH(20),RC
      END IF
C
C**  PRINT OUT THE FILE IF IVU = 1
C
      IF(IVU.EQ.1) THEN
          PRINT 5
          PRINT 4,HDG(1)
          PRINT 6,SUBH(1),DIST(1)
          PRINT 6,SUBH(2),DIST(2)
          PRINT 4,HDG(2)
          DO 34 I=1,NMAC
             PRINT 8,NAME(I),TINTER(I),TINTRA(I),
     C         EAS(I,1),EAS(I,2),EAS(I,3)
 34       CONTINUE
          PRINT 4,HDG(3)
          DO 36 I=1,NP
             PRINT 17,SUBH(I+2),I,CPI(I)
 36       CONTINUE
          PRINT 4,HDG(4)
          DO 38 I=1,2
             PRINT 19,SUBH(I+16),NHA(I)
 38       CONTINUE
          PRINT 19,SUBH(19),NPAL
          PRINT 7,SUBH(20),RC
          PRINT *
          PRINT *,'INPUT ANY CHARACTER TO CONTINUE.'
          READ 2,FNAME
      END IF
C
C**  FORMAT STATEMENTS
C
 2    FORMAT(A6)
 4    FORMAT(A77)
 5    FORMAT(////////////////////////)
 6    FORMAT(A14,F6.0)
 7    FORMAT(A14,F6.1)
 8    FORMAT(3X,A6,5X,5F6.1)
 17   FORMAT(A10,I2,2X,F6.1)
 19   FORMAT(A14,I6)
C
C
      RETURN
      END
```

```
C*********************************************************************
C**  3c
      SUBROUTINE ARMINF
C
C**   READS IN AN EXTERNAL FILE THAT CONTAINS
C**   INFORMATION ABOUT THE ARMY UNITS
C
      CHARACTER NAME(10)*6,HDG*77,FNAME*6,UNAME(11)*14,GNAME(3)*14
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**  FIND THE FILE NAME WITH THE DATA
C
      PRINT 8
      PRINT *,'ENTER THE FILE NAME (6 CHAR MAX) WITH THE ARMY UNITS.'
      READ 2,FNAME
      OPEN(12,FILE=FNAME)
      REWIND(12)
C
C**  ASK IF THE FILE IS TO BE VIEWED
C
      PRINT 8
      PRINT *,'DO YOU WANT TO SEE THE INPUT FILE? (1=Y/0=N)'
 21   READ *,IVU
      IF(IVU.GT.1.OR.IVU.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 21
      END IF
C
C**  READ IN THE DATA FILE AND PRINT IF IVU=1
C**  THE FIRST IYP UNITS ARE DEPLOYED TO THE FRONT
C**  WHILE THE LAST IYP+1 UNITS ARE AT THE APOD
C
 22   READ(12,*)NUNITS,IYP,NHQ(1),NHQ(2)
      WRITE(13,*)NUNITS,IYP,NHQ(1),NHQ(2)
      READ(12,4)HDG
      WRITE(13,4)HDG
      IF(IVU.EQ.1) THEN
         PRINT 8
         PRINT *,NUNITS,IYP,NHQ(1),NHQ(2)
         PRINT 4,HDG
      END IF
      DO 53 I=1,NUNITS
         READ(12,6)UNAME(I),NUNT(I),NTON(I,1),NTON(I,2),NTON(I,3),
     C        NTON(I,4),NTON(I,5),NFP(I),NAT(I),NFT(I),NTAC(I),NPK(I),
     C        NTP(I),NTV(I),IAB(I),NCI(I)
         WRITE(13,6)UNAME(I),NUNT(I),NTON(I,1),NTON(I,2),NTON(I,3),
     C        NTON(I,4),NTON(I,5),NFP(I),NAT(I),NFT(I),NTAC(I),NPK(I),
     C        NTP(I),NTV(I),IAB(I),NCI(I)
         IF(IVU.EQ.0) GO TO 53
         PRINT 6,UNAME(I),NUNT(I),NTON(I,1),NTON(I,2),NTON(I,3),
     C        NTON(I,4),NTON(I,5),NFP(I),NAT(I),NFT(I),NTAC(I),NPK(I),
     C        NTP(I),NTV(I),IAB(I),NCI(I)
```

```
 53   CONTINUE
      CLOSE(12)
      J=NUNITS+1
      UNAME(J)='ALCE-FRONT'
      DO 60 I=1,5
         NTON(J,I)=NTON(NUNITS,I)
 60   CONTINUE
      NTP(J)=NTP(NUNITS)
      NTV(J)=NTV(NUNITS)
      IF(IVU.EQ.1) THEN
         PRINT *
         PRINT *,'INPUT ANY CHARACTER TO CONTINUE.'
         READ 2,FNAME
      END IF
C
C++   FORMAT STATEMENTS
C
 2    FORMAT(A6)
 4    FORMAT(A77)
 6    FORMAT(A14,I2,4I6,I5,5I3,I4,3I3)
 8    FORMAT(////////////////////////)
      CLOSE (12)
C
C
      RETURN
      END
C*********************************************************************
C++   57
      SUBROUTINE ARMINS
C
C++   CREATES THE ARMY UNIT FILE FOR THE ANALYSIS
C
      CHARACTER HDG*77,FNAME*6,FIRST*14
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTAC(10),NFK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C
      PRINT 8
      PRINT *,'     THE FOLLOWING DATA IS NEEDED FOR EACH ARMY UNIT.'
      PRINT *,'------------------------------------------------------------'
      PRINT *
      PRINT *,'UNIT NAME/ID                                  --- 14 CHAR MAX'
      PRINT *,'NUMBER OF UNITS AVAILABLE                     ---  <  100'
      PRINT *,'AMOUNT OF OUTSIZE TONNAGE                     ---  <  100000'
      PRINT *,'           OVERSIZE TONNAGE                   ---  <  100000'
      PRINT *,'           BULK SIZE TONNAGE                  ---  <  100000'
      PRINT *,'NUMBER OF PERSONNEL                           ---  <  100000'
      PRINT *,'SUPPLY CONSUMPTION RATE/DAY                   ---  <  10000'
      PRINT *,'FIREPOWER                                     ---  <  100'
      PRINT *,'ANTI-TANK POWER                               ---  <  100'
      PRINT *,'FRONT LINE TRACE                              ---  <  100'
      PRINT *,'NUMBER OF FIGHTER AC                          ---  <  100
```

```
      PRINT *,'NUMBER OF FIGHTERS ABLE TO PARK AT APOD  ---  <  100'
      PRINT *,'TON-MILES ABLE TO TRANSPORT SUPPLIES/DAY ---  <  1000'
      PRINT *,'MILES/DAY UNIT CAN MOVE ITSELF           ---  <  100'
      PRINT *,'IF THE UNIT IS AIRBORNE CAPABLE.'
      PRINT *,'IF THE UNIT TYPE IS  COMBAT, COMBAT SUPPORT, OR OTHER.'
      PRINT *
      PRINT *,'IF YOU DO NOT HAVE ALL THE ABOVE DATA, YOU MAY TERMINATE
     COR CONTINUE.'
      PRINT *,'DO YOU WANT TO CONTINUE? (1=Y,0=N)'
 10   READ *,NRES
      IF(NRES.GT.1.OR.NRES.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 10
      END IF
      IF(NRES.EQ.0) STOP
C
C**  ASK IF DESIRED TO SAVE DATA IN A FILE
C
      PRINT 8
      PRINT *,'DO YOU WANT THE DATA SAVED IN AN EXTERNAL FILE?(1=Y,0=N)
 12   READ *,NSAVE
      IF(NSAVE.GT.1.OR.NSAVE.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 12
      END IF
      IF(NSAVE.EQ.1) THEN
         PRINT 8
         PRINT *,'ENTER THE NAME OF THE FILE YOU WANT THE DATA SAVED (6
     CCHARACTERS MAX)'
         READ 3,FNAME
         OPEN(12,FILE=FNAME)
         REWIND(12)
      END IF
C
C** START THE INPUT PROCESS
C
      PRINT 8
      PRINT *,'*******************************************************
      PRINT *,'*                        NOTE:                         *
      PRINT *,'*                                                      *
      PRINT *,'*   1. THE UNITS DEPLOYED TO THE FRONT MUST BE ENTERED *
      PRINT *,'*   FIRST, FOLLOWED BY THE UNITS DEPLOYED TO THE APOD. *
      PRINT *,'*                                                      *
      PRINT *,'*   2. IF THERE IS A HEADQUARTERS UNIT, IT MUST        *
      PRINT *,'*   IMMEDIATELY FOLLOW THE UNIT IT IS A HQ FOR.        *
      PRINT *,'*                                                      *
      PRINT *,'*   3.  THE LAST UNIT ENTERED MUST BE THE ALOC UNIT.   *
      PRINT *,'*                                                      *
      PRINT *,'*******************************************************
      I=0
 11   PRINT *
      PRINT *,'-------------------------------------------------------'
      PRINT *,'--            ENTERING  ARMY  UNIT  DATA             --'
      PRINT *,'-------------------------------------------------------'
      PRINT *
```

```
      PRINT *,'INPUT THE UNITS NAME (14 CHAR MAX). IF FINISHED INPUT 0.
      READ 3,FIRST
      IF(FIRST.EQ.'0') GO TO 20
      I=I+1
      UNAME(I)=FIRST
      PRINT *
      PRINT *,'INPUT THE NUMBER OF UNITS (INTEGER) ABLE TO DEPLOY.'
      READ *,NUNT(I)
      PRINT *
      PRINT *,'INPUT THE TONNAGE (INTEGER) FOR THE FOLLOWING SIZE:'
      PRINT *,'      OUT:'
      READ *,NTON(I,1)
      PRINT *,'      OVER:'
      READ *,NTON(I,2)
      PRINT *,'      BULK:'
      READ *,NTON(I,3)
      PRINT *
      PRINT *,'INPUT THE NUMBER OF PERSONNEL (INTEGER) IN THE ',UNAME(I)
      READ *,NTON(I,4)
      PRINT *
      PRINT *,'INPUT THE SUPPLY CONSUMPTION RATE/DAY (INTEGER):'
      READ *,NTON(I,5)
      PRINT *
      PRINT *,'INPUT THE POWER ASSOCIATED WITH THE UNIT (INTEGER) FOR:'
      PRINT *,'      FIREPOWER:'
      READ *,NFP(I)
      PRINT *,'      ANTI-TANK:'
      READ *,NAT(I)
      PRINT *,'      FRONT LINE TRACE:'
      READ *,NFT(I)
      PRINT *
      PRINT *,'INPUT THE # OF FIGHTER AC (INTEGER) IN THE ',UNAME(I)
      READ *,NTAC(I)
      IF(NTAC(I).NE.0) THEN
         PRINT *,'INPUT THE # OF FIGHTERS THAT CAN PARK AT THE APOD:'
         READ *,NPK(I)
         END IF
      PRINT *
      PRINT *,'INPUT THE TON-MILE/DAY (INTEGER) THE UNIT CAN TRANSPORT
     1SUPPLIES:'
      READ *,NTP(I)
      PRINT *
      PRINT *,'INPUT THE MILES/DAY (INTEGER) THE UNIT CAN MOVE ITSELF:'
      READ *,NTM(I)
      PRINT *
      PRINT *,'IS THE UNIT AIRBORNE CAPABLE? (1=Y,0=N).'
58    READ *,IAB(I)
      IF(IAB(I).GT.1.OR.IAB(I).LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 58
      END IF
      PRINT *
      PRINT *,' INDICATE WHICH TYPE OF UNIT IT IS: ANSWER AS FOLLOWS:
      PRINT *,'--------------------------------------------------------
      PRINT *,'            1=COMBAT UNIT '
```

```
      PRINT *,'           -1=COMBAT SUPPORT UNIT (I.E. HQ, OR ARTILLARY
      PRINT *,'            0=OTHER (I.E. ALOC, TRUCK COMP, OR FIGHTER SQ
 68   READ *,NOI(I)
      IF(NOI(I).GT.1.OR.NOI(I).LT.-1) THEN
      PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y,0=N).'
         GO TO 68
      END IF
C
C** CHECK IF THE MEMORY FOR DATA CLOSE TO BEING FULL
C
      IF(I.EQ.9) PRINT *,'YOU ONLY HAVE MEMORY FOR ONE MORE UNIT.'
      IF(I.EQ.10) THEN
        PRINT *
        PRINT *,'*****************************************************
        PRINT *,'**      YOU  ARE  OUT  OF  MEMORY  FOR  ARMY  DATA  **
        PRINT *,'*****************************************************'
        GO TO 20
      END IF
C
C**  GO BACK TO GET MORE DATA
C
      PRINT 8
      GO TO 11
C
C**  END OF THE INPUT
C
 20   PRINT 8
      NUNITS=I
      PRINT *,'HOW MANY HQ UNITS ARE THERE IN THE DATA FILE?. (0,1,2).'
 19   READ *,NQ
      IF(NQ.LT.0.OR.NQ.GT.2) THEN
         PRINT *,'NOT A VALID ANSWER! ENTER ONE (0,1,2).'
         GO TO 19
      END IF
      IF(NQ.NE.0) THEN
         DO 18 I=1,NQ
            PRINT *,'ENTER THE POSITION OF THE HQ UNIT.'
 17         READ *,NHQ(I)
            IF(NHQ(I).LT.2.OR.NHQ(I).GT.NUNITS) THEN
               PRINT *,'NOT A VALID POSTION! RE-ENTER.'
               GO TO 17
            END IF
 18      CONTINUE
      END IF
      J=NUNITS+1
      UNAME(J)='ALOC-FRONT'
      DO 40 I=1,5
         NTIN(J,I)=NTIN(NUNITS,I)
 40   CONTINUE
      NTP(J)=NTP(NUNITS)
      NTU(J)=NTU(NUNITS)
      PRINT *,'HOW MANY UNITS ARE DEPLOYED TO THE FRONT'
 22   READ *,IMP
      IF(IMP.GT.NUNITS) THEN
         PRINT *,'NOT A VALID RESPONSE (IMP > NUNITS).  ENTER AGAIN.'
```

```
            GO TO 22
         END IF
         IF(NSAVE.EQ.1) WRITE(15,*) NUNITS,IYP
         PRINT 8
         PRINT *,'DO YOU WANT TO SEE THE INPUT FILE CREATED? (1=Y/0=N)'
 24      READ *,IVU
         IF(IVU.GT.1.OR.IVU.LT.0) THEN
            PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
            GO TO 24
         END IF
C
C**   WRITE OUT DATA TO THE FILE AND PRINT IF DESIRED
C
         HDG='TYPE           NUMB  OUT  OVER  BULK  PAX  SPLY CP AT FT AC/PK
     1  TP TV AB CI'
            WRITE(13,*)NUNITS,IYP,NHQ(1),NHQ(2)
            WRITE(13,4)HDG
         IF(IVU.EQ.1) THEN
            PRINT 8
            PRINT *,NUNITS,IYP,NHQ(1),NHQ(2)
            PRINT 4,HDG
         END IF
         IF(NSAVE.EQ.1) THEN
            WRITE (12,*)NUNITS,IYP,NHQ(1),NHQ(2)
            WRITE (12,4)HDG
         END IF
         DO 53 I=1,NUNITS
            WRITE(13,6)UNAME(I),NUNT(I),NTON(I,1),NTON(I,2),NTON(I,3),
     C           NTON(I,4),NTON(I,5),NFP(I),NAT(I),NFT(I),NTAC(I),NPK(I),
     C           NTP(I),NTV(I),IAB(I),NCI(I)
            IF(NSAVE.EQ.0) GO TO 54
            WRITE(12,6)UNAME(I),NUNT(I),NTON(I,1),NTON(I,2),NTON(I,3),
     C           NTON(I,4),NTON(I,5),NFP(I),NAT(I),NFT(I),NTAC(I),NPK(I),
     C           NTP(I),NTV(I),IAB(I),NCI(I)
 54         IF(IVU.EQ.0) GO TO 53
            PRINT 6,UNAME(I),NUNT(I),NTON(I,1),NTON(I,2),NTON(I,3),
     C           NTON(I,4),NTON(I,5),NFP(I),NAT(I),NFT(I),NTAC(I),NPK(I),
     C           NTP(I),NTV(I),IAB(I),NCI(I)
 53      CONTINUE
         IF(NSAVE.EQ.1) CLOSE (12)
         IF(IVU.EQ.1) THEN
            PRINT *
            PRINT *,'INPUT ANY CHARACTER TO CONTINUE.'
            READ 3,FNAME
         END IF
C
C**   FORMAT STATEMENTS
C
  3      FORMAT(A4)
  4      FORMAT(A77)
  6      FORMAT(A14,I2,4I6,I5,6I3,I4,3I3)
  8      FORMAT
C
C
         RETURN
```

```
      CHARACTER NAME(10)*8,UNAME(11)*14,GNAME(3)*14,FNAME*8,
     C    HDG(4)*77,SUBH(20)*14,TITLE*77,BLANK*1
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTE(10),
     C    GT(10),MHE(10),NFF(10),NFRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C    NHA(2),NPAL,RC,SLB(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFF(10),NAT(10),NFT(10),
     C    NTHC(10),NPK(10),NTF(11),NTV(11),IAB(10),NCI(10),I/P,NHC(2)
      COMMON/THE/NF,LP,IP,NCR,NEQ,NFRIT,LL(10,2),LU(10,2),LF(10,4,5,4),
     C    LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C    NT(150),LMT(3),NC(10),NWGT(150),MDV(150),NIC
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**   GO TO THE CORRECT TYPE OF FILE
C**    10= AIRCRAFT DATA  20= APOD DATA  30= ARMY DATA
C
      PRINT 7
      GO TO (10,20,30) IFILE
C
C**   AIRCRAFT DATA
C
 10   PRINT *,'ENTER THE FILE NAME DESIRED FOR THE AIRCRAFT DATA (8 CHAR
     1 MAX)'
      READ 2,FNAME
      OPEN(15,FILE=FNAME)
      REWIND(15)
      TITLE='TYPE  NMBR AVL  DRCT APOD INTRA AERN  OUT    OVER  BULK FAX
     1SPD GTM MHE FP PRK'
         WRITE(15,*)NMAC
         WRITE(15,4)TITLE
      DO 14 I=1,NMAC
           WRITE(15,5)NAME(I),NAC(I),AVAIL(I),UTE(I,1),UTE(I,2),
     C          UTE(I,3),UTE(I,4),KARG(I,1,1),KARG(I,1,2),KARG(I,2,1),
     C          KARG(I,2,2),KARG(I,3,1),KARG(I,3,2),KARG(I,4,2),KTE(I),
     C          GT(I),MHE(I),NFF(I),NFRK(I)
 14   CONTINUE
      CLOSE(15)
      RETURN
C
C**   APOD DATA AND HEADINGS
C
 20   PRINT *,'ENTER THE FILE NAME DESIRED FOR THE APOD DATA (8 CHAR
     1MAX)'
      READ 2,FNAME
      OPEN(15,FILE=FNAME)
      REWIND(15)
C
C**   SET UP THE HEADINGS FOR APOD FILE
C
      HDG(1)='1. DISTANCES'
      HDG(2)='2. AIRCRAFT     INTER  INTRA  OUT  OVER  BULK'
      HDG(3)='3. COMBAT VALUES OF UNITS CLOSING'
      HDG(4)='4. MISCELLANEOUS DATA'
      SUBH(1)='    FROM US:'
```

```
      J=NP+2
      DO 23 I=1,3
         PRINT 19,SUBH(I+J),NHA(I)
 23   CONTINUE
C
C**  THE NUMBER OF PALLETS AN ALCE UNIT CAN DOWNLOAD
C
      J=NP+5
      PRINT 19,SUBH(J),NPAL
C
C**  RIGGER CAPABILITY PER DAY DETERMINED
C
      PRINT 17,SUBH(J+1),RC
      PRINT *
      PRINT *
      PRINT *,'INPUT ANY CHARACTER TO CONTINUE.'
      READ 2,BLANK
      PRINT 7
      RETURN
C
C**  ARMY PRINT OUT
C
 31   TITLE='TYPE          NUMB  OUT  OVER  BULK  PAX   SPL CP AT FT AC
     1PA  TF TP  HE CI'
         PRINT *,NUNITS,IXP,NHQ(1),NHQ(2)
         PRINT 4,TITLE
      DO 53 I=1,NUNITS
         PRINT 9,UNAME(I),NUNT(I),NTON(I,1),NTON(I,2),NTON(I,3),
     C        NTON(I,4),NTON(I,5),NFP(I),NAT(I),NFT(I),NTAC(I),NFK(I),
     C        NTP(I),NTV(I),IAB(I),NCI(I)
 53   CONTINUE
      PRINT *
      PRINT *
      RETURN
C
C**  FORMAT STATEMENTS
C
 2    FORMAT(A1)
 4    FORMAT(A77)
 5    FORMAT(A6,I4,5F5.1,1X,3(I3,1X,I2),I4,I4,F4.1,2(I3),I4)
 6    FORMAT(A14,F6.0)
 7    FORMAT(/////////////////////////)
 8    FORMAT(A14,5F6.1)
 9    FORMAT(A14,I2,4I6,I5,5I3,I4,3I3)
 17   FORMAT(A14,F6.1)
 19   FORMAT(A14,I6)
C
C
      END
C******************************************************************
C** S-WRIT
      SUBROUTINE WRIT(IFILE)
C
C**  WRITES TO THE FILE DESIRED BY THE USER
C
```

```
C**  AIRCRAFT DATA
C
 10   TITLE='TYPE  NMBER  AVL ORCT APOD INTRA AERN  OUT   OVER  BULK PAX
     1SPD GTM MHE PP PRR'
        PRINT *,NMAC
        PRINT 4,TITLE
      DO 14 I=1,NMAC
          PRINT 5,NAME(I),NAC(I),AVAIL(I),UTE(I,1),UTE(I,2),UTE(I,3),
     C       UTE(I,4),KARG(I,1,1),KARG(I,1,2),KARG(I,2,1),KARG(I,2,2),
     C       KARG(I,3,1),KARG(I,3,2),KARG(I,4,2),KTS(I),GT(I),MHE(I),
     C       NPP(I),NPRR(I)
 14   CONTINUE
      RETURN
C
C**  APOD DATA AND HEADINGS
C
 20   HDG(1)='1. DISTANCES'
      HDG(2)='2. AIRCRAFT     INTER   INTRA   OUT   OVER   BULK'
      HDG(3)='3. COMBAT VALUES OF UNITS CLOSING'
      HDG(4)='4. MISCELLANEOUS DATA'
      SUBH(1)='    FROM US:'
      SUBH(2)='    FROM CORPS:'
      DO 22 I=3,NP+2
         SUBH(I)='    PERIOD '
 22   CONTINUE
      SUBH(NP+3)='    MHE AT APOD'
      SUBH(NP+4)='    MHE AT FRNT'
      SUBH(NP+5)='    ALOC CAP'
      SUBH(NP+6)='    RIGGER CAP'
C
C**  PRINT OUT THE DISTANCES
C
      PRINT 4,HDG(1)
      DO 23 I=1,2
         PRINT 6,SUBH(I),DIST(I)
 23   CONTINUE
C
C**  PRINT OUT THE INTER AND INTRA TURN-TIMES
C
      PRINT 4,HDG(2)
      DO 24 I=1,NMAC
          PRINT 8,NAME(I),TINTER(I),TINTRA(I),
     C        EAS(I,1),EAS(I,2),EAS(I,3)
 24   CONTINUE
C
C**  PRINT OUT THE COMBAT POWER INDEXES FOR UNITS CLOSING AT THE FRONT
C
      PRINT 4,HDG(3)
      DO 25 I=1,4
         PRINT 17,SUBH(I+2),CPI(I)
 25   CONTINUE
C
C**  NUMBER OF MHE PREPOSITIONED
C
      PRINT 4,HDG(4)
```

```
         END IF
C
C**  IF DONE THEN ASK IF THE DATA IS TO BE SAVED IN A FILE
C
      IF(MSUB.EQ.0) THEN
         PRINT 9
         PRINT *,'SAVE THE NEW INFORMATION IN A FILE? (1=Y/0=N)'
 36      READ *,ISAV
         IF(ISAV.LT.0.OR.ISAV.GT.1) THEN
            PRINT *,'NOT A VALID REPLY! ENTER (1=Y/0=N).'
            GO TO 36
         END IF
         IF(ISAV.EQ.1) CALL WRIT(3)
         GO TO 60
      END IF
      CALL ARMINC(MSUB)
      NREG=1
      GO TO 30
C
C**  FORMAT STATEMENTS
C
 2    FORMAT(A6)
 4    FORMAT(A77)
 6    FORMAT(A14,F6.0)
 8    FORMAT(A14,5F6.1)
 17   FORMAT(A14,F6.1)
 19   FORMAT(A14,I6)
 9    FORMAT(////////////////////////)
      END
C*******************************************************************
C**
      SUBROUTINE PRNT(IFILE)
C
C**  PRINTS OUT THE FILE DESIRED BY THE USER
C
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14,
     C   HDG(4)*77,SUBH(20)*14,TITLE*77,BLANK*1
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/AIF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(3),NPAL,RC,GLS(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTHC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/THE/NP,LP,IF,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**  GO TO THE CORRECT TYPE OF FILE
C**   10= AIRCRAFT DATA  20= APOD DATA  30= ARMY DATA
C
      PRINT 7
      GO TO (10,20,30) IFILE
C
```

```
      PRINT *
      PRINT *,'REPLY 0 IF NO MORE CHANGES DESIRED'
 24   READ *,MSUB
      IF(MSUB.LT.0.OR.MSUB.GT.7) THEN
         PRINT *,'NOT A VALID REPLY!  ENTER (0...7).'
         GO TO 24
         END IF
C
C**  IF DONE THEN ASK IF THE DATA IS TO BE SAVED IN A FILE
C
      IF(MSUB.EQ.0) THEN
         PRINT 9
         PRINT *,'SAVE THE NEW INFORMATION IN A FILE? (1=Y/0=N)'
 26      READ *,ISAV
         IF(ISAV.LT.0.OR.ISAV.GT.1) THEN
            PRINT *,'NOT A VALID REPLY! ENTER (1=Y/0=N).'
            GO TO 26
         END IF
         IF(ISAV.EQ.1) CALL WRIT(2)
         GO TO 60
      END IF
      CALL AFDINC(MSUB)
      NRES=1
      GO TO 23
C
C** IF INFORMATION IS INTERNAL ASK IF A VIEW OF THE DATA IS DESIRED
C
 30   IF(NRES.EQ.0) CALL ARMINF
      IF(NRES.EQ.1) THEN
         PRINT 9
         PRINT *,'DO YOU WANT TO VIEW THE ARMY UNIT DATA? (1=Y/0=N).'
 33      READ *,IVU
         IF(IVU.LT.0.OR.IVU.GT.1) THEN
            PRINT *,'NOT A VALID ANSWER! ENTER (1=Y/0=N).'
            GO TO 33
         END IF
         IF(IVU.EQ.1) CALL PRNT(3)
      END IF
C
C**  SUBMENU FOR ARMY UNIT DATA CHANGE
C
      PRINT *
      PRINT *,'                       ARMY CHANGE SUBMENU'
      PRINT *,'--------------------------------------------------------'
      PRINT *,'      1. DELETE A UNIT.'
      PRINT *,'      2. CHANGE THE NUMBER OF UNITS AVAILABLE.'
      PRINT *,'      3. CHANGE THE FIREPOWER FOR A UNIT.'
      PRINT *,'      4. CHANGE THE ANTI-TANK POWER FOR A UNIT.'
      PRINT *,'      5. CHANGE THE FRONT LINE TRACE FOR A UNIT.'
      PRINT *
      PRINT *,'REPLY 0 IF NO MORE CHANGES DESIRED'
 32   READ *,MSUB
      IF(MSUB.LT.0.OR.MSUB.GT.5) THEN
         PRINT *,'NOT A VALID REPLY!  ENTER (0...7).'
         GO TO 32
```

```
C**  IF DONE THEN ASK IF THE DATA IS TO BE SAVED IN A FILE
C
      IF(MSUB.EQ.0) THEN
         PRINT 9
         PRINT *,'SAVE THE NEW INFORMATION IN A FILE? (1=Y 0=N)
 16      READ *,ISAV
         IF(ISAV.LT.0.OR.ISAV.GT.1) THEN
            PRINT *,'NOT A VALID REPLY! ENTER (1=Y/0=N).'
            GO TO 16
         END IF
         IF(ISAV.EQ.1) CALL WRIT(1)
         GO TO 60
      END IF
      CALL ACFIND(MSUB
      NRES=1
      GO TO 10
C
C**  THE AIRCRAFT DATA MUST BE ENTERED BEFORE THIS POINT
C**  IF INFORMATION IS INTERNAL ASK IF A VIEW OF THE DATA IS DESIRED
C
 20   IF(NRES.EQ.0) THEN
         PRINT *,'HAS THE AIRCRAFT DATA BEEN ENTERED YET? (1=Y 0=N).'
 21      READ *,INAC
         IF(INAC.LT.0.OR.INAC.GT.1) THEN
            PRINT *,'NOT A VALID REPLY   ENTER (1=Y/0=N).'
            GO TO 21
            END IF
         IF(INAC.EQ.0) THEN
            CALL ACINF
            CALL APOINF
         END IF
      END IF
 22   IF(NRES.EQ.1) THEN
         PRINT 9
         PRINT *,'DO YOU WANT TO VIEW THE APOD DATA? (1=Y/0=N).'
 23       READ *,IVU
         IF(IVU.LT.0.OR.IVU.GT.1) THEN
            PRINT *,'NOT A VALID ANSWER! ENTER (1=Y/0=N).'
            GO TO 23
         END IF
         IF(IVU.EQ.1) CALL PRNT(2)
      END IF
C
C**  SUBMENU FOR APOD DATA CHANGE
C
      PRINT 9
      PRINT *,'                    APOD CHANGE SUBMENU'
      PRINT *,'-------------------------------------------------------'
      PRINT *,'      1. CHANGE THE DISTANCE FROM THE US TO THE APOD.'
      PRINT *,'      2. CHANGE THE DISTANCE FROM THE APOD TO THE FRONT.'
      PRINT *,'      3. CHANGE THE COMBAT VALUES FOR THE PERIODS.'
      PRINT *,'      4. CHANGE THE MHE PREPOSITIONED AT THE APOD.'
      PRINT *,'      5. CHANGE THE MHE PREPOSITIONED AT THE FRONT.'
      PRINT *,'      6. CHANGE THE CAPACITY OF THE ALCE.'
      PRINT *,'      7. CHANGE THE CAPACITY OF THE RIGGERS.'
```

```
          END IF
       IF(MENU.EQ.0) THEN
          CALL POSTC
          RETURN
       END IF
       PRINT 9
C
C**  PRINT OUT THE OPTIONS AND INSTRUCTIONS
C
 52    PRINT *,'****  NOTE:'
       PRINT *,'HAS THE DATA TO BE CHANGED BEEN READ OR INPUT INTO THE PR
      1OGRAM'
       PRINT *,'BY A FILE OR INTERACTIVE MEANS? (1=Y/0=N)'
 54    READ *,NRES
       IF(NRES.LT.0.OR.NRES.GT.1) THEN
          PRINT *,'NOT A VALID REPLY!  ENTER (1=Y/0=N).'
          GO TO 54
       END IF
       PRINT 9
C
C**  GO TO THE PROPER SUBMENU
C**   10- AIRCRAFT  20- APOD  30- ARMY
C
       GO TO (10,20,30) MENU
C
C** IF INFORMATION IS INTERNAL ASK IF A VIEW OF THE DATA IS DESIRED
C
 10    IF(NRES.EQ.0) CALL ACINF
          PRINT 9
          PRINT *,'DO YOU WANT TO VIEW THE AIRCRAFT DATA? (1=Y/0=N).'
 12       READ *,IVU
          IF(IVU.LT.0.OR.IVU.GT.1) THEN
             PRINT *,'NOT A VALID ANSWER! ENTER (1=Y/0=N).'
             GO TO 12
          END IF
          IF(IVU.EQ.1) CALL PRNT(1)
C
C**  SUBMENU FOR AIRCRAFT DATA CHANGE
C
       PRINT *
       PRINT *,'                 AIRCRAFT CHANGE SUBMENU'
       PRINT *,'-------------------------------------------------------'
       PRINT *,'      1. DELETE AN AIRCRAFT.'
       PRINT *,'      2. CHANGE THE NUMBER OF AIRCRAFT AVAILABLE.'
       PRINT *,'      3. CHANGE THE AVAILABILITY OF AN AIRCRAFT.'
       PRINT *,'      4. CHANGE THE GROUND TIME FOR AN AIRCRAFT.'
       PRINT *
       PRINT *,'REPLY 0 IF NO MORE CHANGES DESIRED'
       PRINT *
 14    READ *,MSUB
       IF(MSUB.LT.0.OR.MSUB.GT.4) THEN
          PRINT *,'NOT A VALID REPLY!  ENTER ( 1, 2, 3, OR 4).'
          GO TO 14
          END IF
C
```

```
            PRINT *,'**  YOU HAVE NOT ENTERED THE ARMY UNIT DATA YET!! **'
            PRINT *,'***************************************************'
         PRINT 8
            GO TO 13
         END IF
C
C**   FORMAT STATEMENTS
C
 8       FORMAT(/////)
 9       FORMAT(///////////////////////////)
C
C
         RETURN
         END
C**********************************************************************
C**   S-CHG
         SUBROUTINE CHANGE
C
C**   THIS ALLOWS THE USER TO MAKE CERTAIN MINOR CHANGES TO THE AIRCRAFT,
C**   APOD, AND ARMY FILES, ALONG WITH CHANGES IN THE GOALS.
C
         CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14,FNAME*6
         CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
         COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
       C    GT(10),MHE(10),NFP(10),NPRK(10)
         COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
       C    NHA(2),NPAL,RC,GLS(9,3)
         COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
       C    NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
         COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
       C    LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
       C    NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
         COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C** PROVIDE THE MENU FOR THE CHANGES
C
 10      PRINT 9
         PRINT *,'                    SENSITIVITY  MENU'
         PRINT *,'-----------------------------------------------------'
         PRINT *,'      1.  AIRCARFT DATA:'
         PRINT *,'            - DELETE AN AIRCRAFT.'
         PRINT *,'            - CHANGE NUMBER, AVAILABILITY, GROUND TIME.'
         PRINT *,'      2.  APOD DATA:'
         PRINT *,'            - CHANGE DISTANCES, TURNTIMES, COMBAT VALUES'
         PRINT *,'      3.  ARMY DATA:'
         PRINT *,'            - DELETE A UNIT.'
         PRINT *,'            - CHANGE NUMEER AVAILABLE.'
         PRINT *,'            - CHANGE FIREPOWER, ANTI-TANK, FRONT LINE '
         PRINT *,'                 TRACE VALUES.'
         PRINT *
         PRINT *,' [illegible] IF NO MORE CHANGES DESIRED'
 5       READ *,ME
         IF (ME.LT.[illegible].OR.ME.GT.3) THEN
            PRINT *,'[illegible] ENTER (0...3).'
            GO TO [illegible]
```

```
C**     20= AIRCRAFT   30= APOD   40= ARMY
C
      GO TO (20,30,40) NRES
C
C** ENTER THE AIRCRAFT DATA
C
 20   IF(NFILE.EQ.1) THEN
         CALL ACINS(NF)
      ELSE
         CALL ACINF
      END IF
      GO TO 10
C
C** ENTER THE APOD DATA
C
 30   IF(NFILE.EQ.1) THEN
         CALL APDINS(NMAC,NP)
      ELSE
         CALL APDINF
      END IF
      GO TO 10
C
C** ENTER THE ARMY DATA
C
 40   IF(NFILE.EQ.1) THEN
         CALL ARMINS
      ELSE
         CALL ARMINF
      END IF
      GO TO 10
C
C** CHECK TO ENSURE THAT ALL THE DATA HAS BEEN ENTERED
C
 50   IF(NMAC.EQ.0) THEN
         NRES=1
         PRINT 9
         PRINT *,'****************************************************'
         PRINT *,'**   YOU HAVE NOT ENTERED THE AIRCRAFT DATA YET!!  **'
         PRINT *,'****************************************************'
         PRINT 8
         GO TO 13
      END IF
      IF(DIST(1).EQ.0) THEN
         NRES=2
         PRINT 9
         PRINT *,'****************************************************'
         PRINT *,'**    YOU HAVE NOT ENTERED THE APOD DATA YET!!    **'
         PRINT *,'****************************************************'
         PRINT 8
         GO TO 13
      END IF
      IF(NUNITS.EQ.0) THEN
         NRES=3
         PRINT 9
         PRINT *,'****************************************************
```

```
 5    FORMAT('         ',I2,') ',A14)
 6    FORMAT('         ',I2,') ',A14,' - ',I3)
 7    FORMAT('         ',I2,') ',A14,' - ',F3.1)
 9    FORMAT(//////////////////////)
      END
C***********************************************************************
C**  S
      SUBROUTINE POSTC
C
C**  THIS ASKS THE USER AFTER HE/SHE HAS MADE CHANGES IF ALL THE DATA
C**  NECESSARY TO CONTINUE HAS BEEN ENTERED
C
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14,FNAME*6
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C    GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C    NHA(2),NPAL,RC,GLS(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C    NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C    LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C    NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**  FIND OUT WHAT HAS TO BE INPUT BEFORE CONTINUING
C
 10   PRINT 9
      PRINT *,'INDICATE WHAT HAS ** NOT ** BEEN INPUT YET. SELECT ONE.'
      PRINT *,'-------------------------------------------------------'
      PRINT *,'     1. AIRCRAFT DATA.'
      PRINT *,'     2. APOD DATA.'
      PRINT *,'     3. ARMY UNIT DATA.'
      PRINT *,'** INPUT 0 IF ALL DATA HAS BEEN INPUT.'
 12   READ *,NRES
      IF(NRES.LT.0.OR.NRES.GT.3) THEN
         PRINT *,'NOT A VALID REPLY!  ENTER (0...3).'
         GO TO 12
      END IF
      IF(NRES.EQ.0) GO TO 50
C
C**  DATA STILL NEEDS TO BE INPUT- FIND OUT HOW TO ENTER THE DATA
C
      PRINT 9
 13   PRINT *,'HOW WILL YOU ENTER THE DATA? SELECT ONE.'
      PRINT *,'----------------------------------------'
      PRINT *,'     1. INTERACTIVELY.'
      PRINT *,'     2. FROM A USER DEFINED FILE.'
 14   READ *,NFILE
         IF(NFILE.LT.1.OR.NFILE.GT.2) THEN
            PRINT *,'NOT A VALID OPTION, PLEASE ENTER (1,2).'
            GO TO 14
         END IF
C
C** GO TO THE CORRECT STATION TO INPUT THE DATA
```

```
         PRINT *,'NOT A VALID RESPONSE! ENTER AGAIN.'
         GO TO 44
      END IF
      IF(NRES.EQ.0) RETURN
      PRINT *
      PRINT *,'ENTER THE DESIRED FIREPOWER OF ',UNAME(NRES)
      READ *,NFP(NRES)
      RETURN
C
C** CHANGE THE ANTI-TANK POWER OF A UNIT
C
 50   PRINT *,'SELECT THE UNIT YOU DESIRE TO CHANGE THE ANTI-TANK POWER
     1 OF.'
      PRINT *,'------------------------------------------------------------
     1---'
      DO 52 I=1,NUNITS
         PRINT 6,I,UNAME(I),NAT(I)
 52   CONTINUE
      PRINT *
      PRINT *,'0 IF NONE.'
 54   READ *,NRES
      IF(NRES.LT.0.OR.NRES.GT.NUNITS) THEN
         PRINT *,'NOT A VALID RESPONSE! ENTER AGAIN.'
         GO TO 54
      END IF
      IF(NRES.EQ.0) RETURN
      PRINT *
      PRINT *,'ENTER THE DESIRED ANTI-TANK POWER OF ',UNAME(NRES)
      READ *,NAT(NRES)
      RETURN
C
C** CHANGE THE FRONT LINE TRACE OF A UNIT
C
 60   PRINT *,'SELECT THE UNIT YOU DESIRE TO CHANGE THE FRONT LINE TRAC
     1E OF.'
      PRINT *,'------------------------------------------------------------
     1----'
      DO 62 I=1,NUNITS
         PRINT 6,I,UNAME(I),NFT(I)
 62   CONTINUE
      PRINT *
      PRINT *,'0 IF NONE.'
 64   READ *,NRES
      IF(NRES.LT.0.OR.NRES.GT.NUNITS) THEN
         PRINT *,'NOT A VALID RESPONSE! ENTER AGAIN.'
         GO TO 64
      END IF
      IF(NRES.EQ.0) RETURN
      PRINT *
      PRINT *,'ENTER THE DESIRED FRONT LINE TRACE OF ',UNAME(NRES)
      READ *,NFT(NRES)
      RETURN
C
C** FORMAT STATEMENT
C
```

```
            NTON(I,J)=NTON(I+1,J)
 26       CONTINUE
          NFP(I)=NFP(I+1)
          NAT(I)=NAT(I+1)
          NFT(I)=NFT(I+1)
          NTAC(I)=NTAC(I+1)
          NPK(I)=NPK(I+1)
          NTP(I)=NTP(I+1)
          NTV(I)=NTV(I+1)
          IAB(I)=IAB(I+1)
          NCI(I)=NCI(I+1)
 25    CONTINUE
C
C**  SET UP THE DATA FOR THE ALCE AT THE FRONT
C
       J=NUNITS+1
       UNAME(J)='ALCE-FRONT'
       DO 61 I=1,5
          NTON(J,I)=NTON(NUNITS,I)
 61    CONTINUE
       NTP(J)=NTP(NUNITS)
       NTV(J)=NTV(NUNITS)
       RETURN
C
C** CHANGE THE NUMBER OF UNITS AVAILABLE FOR THE DEPLOYMENT
C
 30    PRINT *,'  SELECT THE UNIT YOU DESIRE TO INCREASE THE NUMBER OF'
       PRINT *,'-------------------------------------------------------'
       DO 32 I=1,NUNITS
          PRINT 6,I,UNAME(I),NUNT(I)
 32    CONTINUE
       PRINT *
       PRINT *,'0 IF NONE.'
 34    READ *,NRES
       IF(NRES.LT.0.OR.NRES.GT.NUNITS) THEN
          PRINT *,'NOT A VALID RESPONSE! ENTER AGAIN.'
          GO TO 34
       END IF
       IF(NRES.EQ.0) RETURN
       PRINT *
       PRINT *,'ENTER THE DESIRED NUMBER OF ',UNAME(NRES)
       READ *,NUNT(NRES)
       RETURN
C
C** CHANGE THE AVAILABILITY OF AN AIRCRAFT
C
 40    PRINT *,'  SELECT THE UNIT YOU DESIRE TO CHANGE THE FIREPOWER OF'
       PRINT *,'-------------------------------------------------------'
       DO 42 I=1,NUNITS
          PRINT 6,I,UNAME(I),NFP(I)
 42    CONTINUE
       PRINT *
       PRINT *,'0 IF NONE.'
 44    READ *,NRES
       IF(NRES.LT.0.OR.NRES.GT.NUNITS) THEN
```

```
C** CHANGE THE CAPACITY OF THE RIGGERS
C
 70   PRINT *,'ENTER THE NEW LOADS/DAY OF THE RIGGERS (REAL).'
      READ *,RC
C
C**  FORMAT STATEMENTS
C
 9    FORMAT(////////////////////////)
C
C
      RETURN
      END
C***********************************************************************
C** 5
      SUBROUTINE ARMINC(ICHG)
C
C**  THIS WILL MAKE CHANGES AS DESIRED FROM THE CHANGE SUBROUTINE
C**  FOR THE ARMY UNIT DATA
C
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14,FNAME
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**  GO TO THE CORRECT STATION FOR THE CHANGE
C
      PRINT 9
      GO TO (20,30,40,50) ICHG
C
C** DELETE AN ARMY UNIT FROM THE DATA LIST
C
 20   PRINT *,'      SELECT ONE OF THE ARMY UNITS TO DELETE'
      PRINT *,'-----------------------------------------------'
      DO 22 I=1,NUNITS-1
        PRINT 5,I,UNAME(I)
 22   CONTINUE
      PRINT *
      PRINT *,'0 IF NONE.'
 24   READ *,NRES
      IF(NRES.LT.0.OR.NRES.GT.NUNITS) THEN
         PRINT *,'NOT A VALID RESPONSE! ENTER AGAIN.'
         GO TO 24
      END IF
      IF(NRES.EQ.0) RETURN
      IF(NRES.LT.NHQ(1)) NHQ(1)=NHQ(1)-1
      IF(NRES.EQ.NHQ(1)) NHQ(1)=0
      IF(NRES.LT.NHQ(2)) NHQ(2)=NHQ(2)-1
      IF(NRES.EQ.NHQ(2)) NHQ(2)=0
      IF(NRES.LE.IYP) IYP=IYP-1
      NUNITS=NUNITS-1
      DO 25 I=NRES,NUNITS
         UNAME(I)=UNAME(I+1)
         NUNT(I)=NUNT(I+1)
         DO 26 J=1,5
```

```
      END
C*********************************************************************
C** 9
      SUBROUTINE APDINC(ICHG)
C
C**  THIS WILL MAKE CHANGES AS DESIRED FROM THE CHANGE SUBROUTINE
C**  FOR THE APOD DATA
C
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
C
C**  GO TO THE CORRECT STATION FOR THE CHANGE
C
      PRINT 9
      GO TO (10,20,30,40,50,60,70) ICHG
C
C** CHANGE THE DISTANCE FROM THE US TO THE APOD
C
 10   PRINT *,'ENTER THE NEW DISTANCE (REAL) FROM THE US TO THE APOD.'
      READ *,DIST(1)
      RETURN
C
C** CHANGE THE DISTANCE FROM THE APOD TO THE FRONT
C
 20   PRINT *,'ENTER THE NEW DISTANCE(REAL) FROM THE APOD TO THE FRONT.'
      READ *,DIST(2)
      RETURN
C
C** CHANGE THE COMBAT VALUES OF CLOSING UNITS
C
 30   PRINT *,'ENTER THE COMBAT VALUES FOR THE FOLLOWING PERIODS:'
      DO 32 I=1,NP
         PRINT *,'  FOR PERIOD#',I
         READ *,CPI(I)
 32   CONTINUE
      RETURN
C
C** CHANGE THE MHE PREPOSITIONED AT THE APOD
C
 40   PRINT *,'ENTER THE NEW MHE PREPOSITIONED AT THE APOD (INTEGER).'
      READ *,NHA(1)
      RETURN
C
C** CHANGE THE MHE PREPOSITIONED AT THE FRONT
C
 50   PRINT *,'ENTER THE NEW MHE PREPOSITIONED AT THE FRONT (INTEGER).'
      READ *,NHA(2)
      RETURN
C
C** CHANGE THE CAPACITY OF THE ALCE
C
 60   PRINT *,'ENTER THE NEW CAPACITY OF THE ALCE (INTEGER).'
      READ *,NPAL
      RETURN
C
```

```
      SUBH(2)='   FROM CORPS:'
      DO 22 I=3,NP+2
         SUBH(I)='   PERIOD '
 22   CONTINUE
      SUBH(NP+3)='   MHE AT APOD'
      SUBH(NP+4)='   MHE AT FRNT'
      SUBH(NP+5)='   ALCE CAP'
      SUBH(NP+6)='   RIGGER CAP'
C
C**  WRITE THE DISTANCES
C
      WRITE(15,4)HDG(1)
      DO 23 I=1,2
         WRITE(15,6)SUBH(I),DIST(I)
 23   CONTINUE
C
C**  WRITE THE INTER AND INTRA TURN-TIMES
C
      WRITE(15,4)HDG(2)
      DO 24 I=1,NMAC
           WRITE(15,8)NAME(I),TINTER(I),TINTRA(I),
     C        EAS(I,1),EAS(I,2),EAS(I,3)
 24   CONTINUE
C
C**  WRITE THE COMBAT POWER INDEXES FOR UNITS CLOSING AT THE FRONT
C
      WRITE(15,4)HDG(3)
      DO 26 I=1,4
         WRITE(15,17)SUBH(I+2),CPI(I)
 26   CONTINUE
C
C**  NUMBER OF MHE PREPOSITIONED
C
      WRITE(15,4)HDG(4)
      J=NP+2
      DO 28 I=1,2
         WRITE(15,19)SUBH(I+J),NHA(I)
 28   CONTINUE
C
C**  THE NUMBER OF PALLETS AN ALCE UNIT CAN DOWNLOAD
C
      J=NP+5
      WRITE(15,19)SUBH(J),NPAL
C
C**  RIGGER CAPABILITY PER DAY DETERMINED
C
      WRITE(15,6)SUBH(J+1),RC
      CLOSE(15)
      RETURN
C
C**  WRITE A FILE FOR ARMY DATA
C
 30   PRINT *,'ENTER THE FILE NAME DESIRED FOR THE ARMY DATA (6 CHAR
     1MAX).'
      READ 2,FNAME
```

```
      OPEN(15,FILE=FNAME)
      REWIND(15)
      TITLE='TYPE          NUME   OUT   OVER   BULK   PAX   SFL   CP AT FT AC
     1PK  TP TV AB CI'
         WRITE(15,*)NUNITS,IYP,NHQ(1),NHQ(2)
         WRITE(15,4)TITLE
      DO 53 I=1,NUNITS
         WRITE(15,9)UNAME(I),NUNT(I),NTON(I,1),NTON(I,2),NTON(I,3),
     C        NTON(I,4),NTON(I,5),NFP(I),NAT(I),NFT(I),NTAC(I),NPK(I),
     C        NTP(I),NTV(I),IAB(I),NCI(I)
 53   CONTINUE
      CLOSE(15)
      RETURN
C
C**  FORMAT STATEMENTS
C
 2    FORMAT(A6)
 4    FORMAT(A77)
 5    FORMAT(A6,I4,5F5.1,1X,3(I3,1X,I2),I4,I4,F4.1,2(I3),I4)
 6    FORMAT(A14,F6.0)
 7    FORMAT(//////////////////////////'-')
 8    FORMAT(A14,5F6.1)
 9    FORMAT(A14,I2,4I6,I5,5I3,I4,3I3)
 17   FORMAT(A14,F6.1)
 19   FORMAT(A14,I6)
C
C
      END
C*********************************************************************
C**  S9
      SUBROUTINE REALC
C
C**
C**  THIS BUILDS THE EQUALITY CONSTRAINTS FOR THE FOLLOWING ISSUES:
C**       1.  SHIPMENT OF UNITS TO THE APOD
C**       2.  SHIPMENT OF UNITS TO THE FRONT VIA DIRECT DELIVERY
C**       3.  SHIPMENT OF UNITS TO THE FRONT VIA AIRBORNE DELIVERY
C**       4.  SHIPMENT OF SUPPLIES FOR THE THEATER
C**       5.  SHIPMENT OF SUPPLIES FOR THE FRONT
C**       6.  SHIPMENT OF SUPPLIES FOR THE APOD
C**       7.  RIGGER CAPABILITY
C**
C
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14,MS(4)*5,KG(5)*4,
     1    MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C    GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C    NHA(2),NPAL,RC,GLS(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C    NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/TAB/NF,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C    LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C    NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
```

```
C
C**  CHECK TO SEE IF ECHO DESIRED
C
      PRINT *,'---------------------------------------------------------'
      PRINT *,'                     EQUALITY  CONSTRAINTS'
      PRINT *,'---------------------------------------------------------'
      WRITE(13,*)'----------------------------------------------------'
      WRITE(13,*)'                     EQUALITY  CONSTRAINTS'
      WRITE(13,*)'----------------------------------------------------'
*     PRINT *,'ECHO ON THE EQUALITY CONSTRAINTS?(1=Y,0=N).'
*     READ *,LANS
      LANS=0
C-1
C**   CONSTRAINT FOR THE SHIPMENT OF DEPLOYED UNITS TO THE FRONT
C
      PRINT *,'---------------------------------'
      PRINT *,'     UNIT  SHIPMENT  TO  APOD'
      PRINT *,'---------------------------------'
      WRITE(13,*)'-----------------------------'
      WRITE(13,*)'   UNIT  SHIPMENT  TO  APOD'
      WRITE(13,*)'-----------------------------'
C**  FOR EACH PERIOD
      DO 90 L=1,NP
C
C**  FOR OUT, OVER, AND BULK CARGO
C
         DO 92 K=1,3
            NEQ=NEQ+1
C.....................................................................
C-
C**  FOR EACH TYPE OF AIRCRAFT
            DO 94 I=1,NMAC
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE TYPE
C**    OF MISSON L(I,1), TYPE OF CARGO L(I,2), OR FP
C
               IF(2.LT.LL(I,1) .OR. 2.GT.LU(I,1)) GO TO 94
               IF(K.LT.LL(I,2) .OR. K.GT.LU(I,2)) GO TO 94
               IF(L.LT.NFP(I)) GO TO 94
               AIJ(NEQ,LPX(I,2,K,L))= KARG(I,K,1)
               WRITE(13,04)NEQ,LPX(I,2,K,L),AIJ(NEQ,LPX(I,2,K,L)),
     1            NAME(I),MS(2),KG(K),L
               IF (LANS.EQ.0) GO TO 94
               PRINT 04,NEQ,LPX(I,2,K,L),AIJ(NEQ,LPX(I,2,K,L)),
     1            NAME(I),MS(2),KG(K),L
 94         CONTINUE
C
C**  FOR EACH TYPE OF UNIT SHIPPED TO THE APOD, J=2 FOR THOSE REMAINING
C**  AT THE APOD OR WALKING TO THE FRONT, J=3 FOR THOSE UNITS DEPLOYED
C**  TO THE FRONT BUT FLYING INTRATHEATER AIRLIFT
C
            DO 96 I=1,NUNITS+1
               IF(IAB(I).EQ.1) GO TO 96
               DO 97 J=2,3
                  IF(I.GT.IYP.AND.J.NE.2.AND.I.LE.NUNITS) GO TO 97
```

```
                  AIJ(NEQ,LPU(I,J,L))= -NTON(I,K)
                  WRITE(13,03)NEQ,LPU(I,J,L),AIJ(NEQ,LPU(I,J,L)),
     1               UNAME(I),MD(J),L
                  IF (LANS.EQ.0) GO TO 97
                  PRINT 03,NEQ,LPU(I,J,L),AIJ(NEQ,LPU(I,J,L)),
     1               UNAME(I),MD(J),L
 97             CONTINUE
 96           CONTINUE
C
C**  THE EXCESS FOR THIS PERIOD
C
              AIJ(NEQ,LPS(2,K,L))= -1.0
                  WRITE(13,02)NEQ,LPS(2,K,L),AIJ(NEQ,LPS(2,K,L))
                  IF (LANS.EQ.0) GO TO 98
                  PRINT 02,NEQ,LPS(2,K,L),AIJ(NEQ,LPS(2,K,L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 98           IF(L.NE.1) AIJ(NEQ,LPS(2,K,L-1))= 1.0
              IF(L.EQ.1) GO TO 99
                  WRITE(13,02)NEQ,LPS(2,K,L-1),AIJ(NEQ,LPS(2,K,L-1))
                  IF (LANS.EQ.0) GO TO 99
                  PRINT 02,NEQ,LPS(2,K,L-1),AIJ(NEQ,LPS(2,K,L-1))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 99           RHS(NEQ)= 0.0
              WRITE(13,08)NEQ,RHS(NEQ)
              IF(LANS.EQ.0) GO TO 92
              PRINT 08,NEQ,RHS(NEQ)
C.......................................................................
 92         CONTINUE
C**  FOR PASSENGERS
              NEQ=NEQ+1
C........................................................................
C**  FOR EACH TYPE OF AIRCRAFT
              DO 100 I=1,NMAC
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE TYPE
C**    OF MISSON L(I,1) OR NFP
C
                IF(2.LT.LL(I,1) .OR. 2.GT.LU(I,1)) GO TO 100
                IF(L.LT.NFP(I)) GO TO 100
                DO 102 K=LL(I,2),LU(I,2)
                  AIJ(NEQ,LPX(I,2,K,L))= KARG(I,K,2)
                  WRITE(13,04)NEQ,LPX(I,2,K,L),AIJ(NEQ,LPX(I,2,K,L)),
     1               NAME(I),MS(2),KG(K),L
                  IF (LANS.EQ.0) GO TO 103
                  PRINT 04,NEQ,LPX(I,2,K,L),AIJ(NEQ,LPX(I,2,K,L)),
     1               NAME(I),MS(2),KG(K),L
C
C**  CONSIDER SUPPLY CARGO IF BULK CARGO IS CONSIDERED
C
 103          IF(K.EQ.3) THEN
                AIJ(NEQ,LPX(I,2,5,L))=KARG(I,5,1)
```

```
                WRITE(13,04)NEQ,LPX(I,2,5,L),AIJ(NEQ,LPX(I,2,5,L)),
     1             NAME(I),MS(2),KG(5),L
                   IF(LANS.EQ.0) GO TO 102
             ELSE
                GO TO 102
             END IF
                PRINT 04,NEQ,LPX(I,2,5,L),AIJ(NEQ,LPX(I,2,5,L)),
     1             NAME(I),MS(2),KG(5),L
 102              CONTINUE
 100           CONTINUE
C
C**  FOR EACH TYPE OF UNIT
C
             DO 104 I=1,NUNITS+1
                IF(IAB(I).EQ.1) GO TO 104
                DO 105 J=2,3
                   IF(I.GT.IYP.AND.J.NE.2.AND.I.LE.NUNITS) GO TO 105
                   AIJ(NEQ,LPU(I,J,L))= -NTON(I,4)
                   WRITE(13,03)NEQ,LPU(I,J,L),AIJ(NEQ,LPU(I,J,L)),
     1               UNAME(I),MD(J),L
                   IF (LANS.EQ.0) GO TO 105
                   PRINT 03,NEQ,LPU(I,J,L),AIJ(NEQ,LPU(I,J,L)),
     1                UNAME(I),MD(J),L
 105              CONTINUE
 104           CONTINUE
C
C**  THE EXCESS FOR THIS PERIOD
C
             AIJ(NEQ,LPS(2,4,L))= -1.0
                   WRITE(13,02)NEQ,LPS(2,4,L),AIJ(NEQ,LPS(2,4,L))
                   IF (LANS.EQ.0) GO TO 106
                   PRINT 02,NEQ,LPS(2,4,L),AIJ(NEQ,LPS(2,4,L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 106           IF(L.NE.1) AIJ(NEQ,LPS(2,4,L-1))= 1.0
             IF(L.EQ.1) GO TO 107
                   WRITE(13,02)NEQ,LPS(2,4,L-1),AIJ(NEQ,LPS(2,4,L-1))
                   IF (LANS.EQ.0) GO TO 107
                   PRINT 02,NEQ,LPS(2,4,L-1),AIJ(NEQ,LPS(2,4,L-1))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 107           RHS(NEQ)= 0.0
             WRITE(13,08)NEQ,RHS(NEQ)
             IF(LANS.EQ.0) GO TO 90
             PRINT 08,NEQ,RHS(NEQ)
C...................................................................
 90    CONTINUE
C-2
C**  SET UP EQUATIONS FOR THE SHIPMENT OF UNITS VIA
C**  DIRECT DELIVERY (J=1) ONLY IF THERE ARE DIRECT
C**  DELIVERY AC AVAILABLE (LMT(1).NE.0)
C
       IF(LMT(1).EQ.0) GO TO 07
```

```
      PRINT *,'----------------------------------'
      PRINT *,'      UNIT  SHIPMENT  DIRECT'
      PRINT *,'----------------------------------'
      WRITE(13,*)'----------------------------------'
      WRITE(13,*)'      UNIT  SHIPMENT  DIRECT'
      WRITE(13,*)'----------------------------------'
C**  FOR EACH PERIOD
      DO 10 L=1,NP
C
C**  FOR OUT, OVER, AND BULK CARGO
C
         DO 12 K=1,3
            NEQ=NEQ+1
C.......................................................................
C**  FOR EACH TYPE OF AIRCRAFT
            DO 14 I=1,NMAC
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE TYPE
C**    OF MISSION L(I,1), TYPE OF CARGO L(I,2), OR FP
C
                  IF(1.LT.LL(I,1) .OR. 1.GT.LU(I,1)) GO TO 14
                  IF(K.LT.LL(I,2) .OR. K.GT.LU(I,2)) GO TO 14
                  IF(L.LT.NFP(I)) GO TO 14
                  AIJ(NEQ,LPX(I,1,K,L))= KARG(I,K,1)
                  WRITE(13,04)NEQ,LPX(I,1,K,L),AIJ(NEQ,LPX(I,1,K,L)),
     1               NAME(I),MS(1),KG(K),L
                  IF (LANS.EQ.0) GO TO 14
                  PRINT 04,NEQ,LPX(I,1,K,L),AIJ(NEQ,LPX(I,1,K,L)),
     1               NAME(I),MS(1),KG(K),L
 14         CONTINUE
C**  FOR EACH UNIT THAT IS NOT AIRBORNE CAPABLE
C
            DO 16 I=1,NUNITS+1
              IF(IAB(I).EQ.1) GO TO 16
              IF(I.GT.IYP.AND.I.LE.NUNITS) GO TO 16
                  AIJ(NEQ,LPU(I,1,L))= -NTON(I,K)
                  WRITE(13,03)NEQ,LPU(I,1,L),AIJ(NEQ,LPU(I,1,L)),
     1               UNAME(I),MD(1),L
                  IF (LANS.EQ.0) GO TO 16
                  PRINT 03,NEQ,LPU(I,1,L),AIJ(NEQ,LPU(I,1,L)),
     1               UNAME(I),MD(1),L
 16         CONTINUE
C
C**  THE EXCESS FOR THIS PERIOD
C
            AIJ(NEQ,LPS(1,K,L))= -1.0
                  WRITE(13,02)NEQ,LPS(1,K,L),AIJ(NEQ,LPS(1,K,L))
                  IF (LANS.EQ.0) GO TO 18
                  PRINT 02,NEQ,LPS(1,K,L),AIJ(NEQ,LPS(1,K,L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 18         IF(L.NE.1) AIJ(NEQ,LPS(1,K,L-1))= 1.0
            IF(L.EQ.1) GO TO 19
                  WRITE(13,02)NEQ,LPS(1,K,L-1),AIJ(NEQ,LPS(1,K,L-1))
```

```
                 IF (LANS.EQ.0) GO TO 19
                 PRINT 02,NEQ,LPS(1,K,L-1),AIJ(NEQ,LPS(1,K,L-1))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 19          RHS(NEQ)= 0.0
             WRITE(13,08)NEQ,RHS(NEQ)
             IF(LANS.EQ.0) GO TO 12
             PRINT 08,NEQ,RHS(NEQ)
C...........................................................................
 12        CONTINUE
C**  FOR PASSENGERS
             NEQ=NEQ+1
C............................................................................
C**  FOR EACH TYPE OF AIRCRAFT
             DO 20 I=1,NMAC
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE TYPE
C**    OF MISSON L(I,1) OR NFP
C
                IF(1.LT.LL(I,1) .OR. 1.GT.LU(I,1)) GO TO 20
                IF(L.LT.NFP(I)) GO TO 20
                DO 22 K=LL(I,2),LU(I,2)
                   AIJ(NEQ,LPX(I,1,K,L))= KARG(I,K,2)
                   WRITE(13,04)NEQ,LPX(I,1,K,L),AIJ(NEQ,LPX(I,1,K,L)),
     1                NAME(I),MS(1),KG(K),L
                   IF (LANS.EQ.0) GO TO 23
                   PRINT 04,NEQ,LPX(I,1,K,L),AIJ(NEQ,LPX(I,1,K,L)),
     1                NAME(I),MS(1),KG(K),L
C
C**  CONSIDER SUPPLY CARGO IF BULK CARGO IS CONSIDERED
C
 23         IF(K.EQ.3) THEN
                AIJ(NEQ,LPX(I,1,5,L))=KARG(I,5,1)
                WRITE(13,04)NEQ,LPX(I,1,5,L),AIJ(NEQ,LPX(I,1,5,L)),
     1             NAME(I),MS(1),KG(5),L
                   IF(LANS.EQ.0) GO TO 22
             ELSE
                GO TO 22
             END IF
                PRINT 04,NEQ,LPX(I,1,5,L),AIJ(NEQ,LPX(I,1,5,L)),
     1             NAME(I),MS(1),KG(5),L
 22             CONTINUE
 20          CONTINUE
C**  FOR EACH TYPE OF UNIT
             DO 24 I=1,NUNITS+1
            IF(IAB(I).EQ.1.) GO TO 24
            IF(I.GT.IYP.AND.I.LE.NUNITS) GO TO 24
                   AIJ(NEQ,LPU(I,1,L))= -NTON(I,4)
                   WRITE(13,03)NEQ,LPU(I,1,L),AIJ(NEQ,LPU(I,1,L)),
     1                UNAME(I),MD(1),L
                   IF (LANS.EQ.0) GO TO 24
                   PRINT 03,NEQ,LPU(I,1,L),AIJ(NEQ,LPU(I,1,L)),
     1                UNAME(I),MD(1),L
 24          CONTINUE
```

```
C
C**  THE EXCESS FOR THIS PERIOD
C
                     AIJ(NEQ,LPS(1,4,L))= -1.0
                     WRITE(13,02)NEQ,LPS(1,4,L),AIJ(NEQ,LPS(1,4,L))
                     IF (LANS.EQ.0) GO TO 26
                     PRINT 02,NEQ,LPS(1,4,L),AIJ(NEQ,LPS(1,4,L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 26           IF(L.NE.1) AIJ(NEQ,LPS(1,4,L-1))= 1.0
              IF(L.EQ.1) GO TO 27
                     WRITE(13,02)NEQ,LPS(1,4,L-1),AIJ(NEQ,LPS(1,4,L-1))
                     IF (LANS.EQ.0) GO TO 27
                     PRINT 02,NEQ,LPS(1,4,L-1),AIJ(NEQ,LPS(1,4,L-1))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 27           RHS(NEQ)= 0.0
              WRITE(13,08)NEQ,RHS(NEQ)
              IF(LANS.EQ.0) GO TO 10
              PRINT 08,NEQ,RHS(NEQ)
C.......................................................................
 10    CONTINUE
C-3
C**  SET UP EQUATIONS FOR THE SHIPMENT
C**  OF UNITS TO THE APOD VIA AIRBRN DELIVERY
C
 07    IF(LMT(2).EQ.0.OR.LMT(3).EQ.0) GO TO 48
       PRINT *,'-----------------------------------'
       PRINT *,'     UNIT  SHIPMENT  AIRBRN'
       PRINT *,'-----------------------------------'
       WRITE(13,*)'-----------------------------------'
       WRITE(13,*)'     UNIT  SHIPMENT  AIRBRN'
       WRITE(13,*)'-----------------------------------'
C**  FOR EACH PERIOD
     DO 30 L=1,NP
C
C**  FOR OUT, OVER, AND BULK CARGO
C
         DO 32 K=1,3
            NEQ=NEQ+1
C.......................................................................
C**  FOR EACH TYPE OF AIRCRAFT
           DO 34 I=1,NMAC
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE TYPE
C**    OF MISSON L(I,1), TYPE OF CARGO L(I,2), OR FP
C
                  IF(4.LT.LL(I,1) .OR. 4.GT.LU(I,1)) GO TO 34
                     IF(K.LT.LL(I,2) .OR. K.GT.LU(I,2)) GO TO 34
                     IF(L.LT.NFP(I)) GO TO 34
                     AIJ(NEQ,LPX(I,4,K,L))= KARG(I,K,1)
                     WRITE(13,04)NEQ,LPX(I,4,K,L),AIJ(NEQ,LPX(I,4,K,L)),
     1                  NAME(I),MS(4),KG(K),L
```

```
                IF (LANS.EQ.0) GO TO 34
                PRINT 04,NEQ,LPA(I,4,K,L),AIJ(NEQ,LPA(I,4,K,L)),
     1             NAME(I),MS(4),KG(K),L
 34         CONTINUE
C
C**  FOR EACH TYPE OF UNIT AIRBORNE CAPABLE
C
            DO 36 I=1,NUNITS+1
                IF(IAB(I).EQ.0) GO TO 36
                AIJ(NEQ,LPU(I,1,L))= -NTON(I,K)
                WRITE(13,03)NEQ,LPU(I,1,L),AIJ(NEQ,LPU(I,1,L)),
     1             UNAME(I),MD(1),L
                IF (LANS.EQ.0) GO TO 36
                PRINT 03,NEQ,LPU(I,1,L),AIJ(NEQ,LPU(I,1,L)),
     1             UNAME(I),MD(1),L
 36         CONTINUE
C
C**  THE EXCESS FOR THIS PERIOD
C
            AIJ(NEQ,LPS(3,K,L))= -1.0
                WRITE(13,02)NEQ,LPS(3,K,L),AIJ(NEQ,LPS(3,K,L))
                IF (LANS.EQ.0) GO TO 38
                PRINT 02,NEQ,LPS(3,K,L),AIJ(NEQ,LPS(3,K,L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 38         IF(L.NE.1) AIJ(NEQ,LPS(3,K,L-1))= 1.0
            IF(L.EQ.1) GO TO 39
                WRITE(13,02)NEQ,LPS(3,K,L-1),AIJ(NEQ,LPS(3,K,L-1))
                IF (LANS.EQ.0) GO TO 39
                PRINT 02,NEQ,LPS(3,K,L-1),AIJ(NEQ,LPS(3,K,L-1))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 39         RHS(NEQ)= 0.0
            WRITE(13,08)NEQ,RHS(NEQ)
            IF(LANS.EQ.0) GO TO 32
            PRINT 08,NEQ,RHS(NEQ)
C.....................................................................
 32      CONTINUE
C
C**  FOR PASSENGERS
C
            NEQ=NEQ+1
C......................................................................
C**  FOR EACH TYPE OF AIRCRAFT
            DO 40 I=1,NMAC
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE TYPE
C**         OF MISSON L(I,1) OR NFP
C
               IF(4.LT.LL(I,1) .OR. 4.GT.LU(I,1)) GO TO 40
               IF(L.LT.NFP(I)) GO TO 40
               DO 42 K=LL(I,2),LU(I,2)
                  AIJ(NEQ,LPA(I,4,K,L))= KARG(I,K,2)
```

```
              WRITE(13,04)NEQ,LPX(I,4,K,L),AIJ(NEQ,LPX(I,4,K,L)),
     1          NAME(I),MS(4),KG(K),L
              IF (LANS.EQ.0) GO TO 43
              PRINT 04,NEQ,LPX(I,4,K,L),AIJ(NEQ,LPX(I,4,K,L)),
     1          NAME(I),MS(4),KG(K),L
C
C**  CONSIDER SUPPLY CARGO IF BULK CARGO IS CONSIDERED
C
 43       IF(K.EQ.3) THEN
             AIJ(NEQ,LPX(I,4,5,L))=KARG(I,5,1)
             WRITE(13,04)NEQ,LPX(I,4,5,L),AIJ(NEQ,LPX(I,4,5,L)),
     1          NAME(I),MS(4),KG(5),L
              IF(LANS.EQ.0) GO TO 42
          ELSE
             GO TO 42
          END IF
             PRINT 04,NEQ,LPX(I,4,5,L),AIJ(NEQ,LPX(I,4,5,L)),
     1          NAME(I),MS(4),KG(5),L
 42          CONTINUE
 40       CONTINUE
C
C**  FOR EACH TYPE OF UNIT AIRBORNE CAPABLE
C
          DO 44 I=1,IYP
              IF(IAB(I).EQ.0) GO TO 44
              AIJ(NEQ,LPU(I,1,L))= -NTON(I,4)
              WRITE(13,03)NEQ,LPU(I,1,L),AIJ(NEQ,LPU(I,1,L)),
     1          UNAME(I),MD(1),L
              IF (LANS.EQ.0) GO TO 44
              PRINT 03,NEQ,LPU(I,1,L),AIJ(NEQ,LPU(I,1,L)),
     1          UNAME(I),MD(1),L
 44       CONTINUE
C
C**  THE EXCESS FOR THIS PERIOD
C
          AIJ(NEQ,LPS(3,4,L))= -1.0
              WRITE(13,02)NEQ,LPS(3,4,L),AIJ(NEQ,LPS(3,4,L))
              IF (LANS.EQ.0) GO TO 46
              PRINT 02,NEQ,LPS(3,4,L),AIJ(NEQ,LPS(3,4,L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 46       IF(L.NE.1) AIJ(NEQ,LPS(3,4,L-1))= 1.0
          IF(L.EQ.1) GO TO 47
              WRITE(13,02)NEQ,LPS(3,4,L-1),AIJ(NEQ,LPS(3,4,L-1))
              IF (LANS.EQ.0) GO TO 47
              PRINT 02,NEQ,LPS(3,4,L-1),AIJ(NEQ,LPS(3,4,L-1))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 47       RHS(NEQ)= 0.0
          WRITE(13,08)NEQ,RHS(NEQ)
          IF(LANS.EQ.0) GO TO 30
          PRINT 08,NEQ,RHS(NEQ)
C.....................................................................
```

```
 30    CONTINUE
C
C**   SET UP EQUATIONS FOR THE SHIPMENT
C**   OF SUPPLIES THE THEATER
C
 48    PRINT *,'---------------------------------'
       PRINT *,'          THEATER   SUPPLIES'
       PRINT *,'---------------------------------
       WRITE(13,*)'---------------------------------'
       WRITE(13,*)'          THEATER   SUPPLIES'
       WRITE(13,*)'---------------------------------'
C
C**   FOR EACH PERIOD AFTER THE INITIAL PERIOD OF DEPLOYMENT
C
       DO 49 L=2,NP
          NEQ=NEQ+1
C.............................................................
C**   FOR EACH TYPE OF AIRCRAFT
          DO 50 I=1,NMAC
C
C**   FOR EACH MISSION EXCEPT INTRA
C
             DO 51 J=LL(I,1),LU(I,1)
                IF(J.EQ.3) GO TO 51
C
C**   CHECK TO SEE IF BEYOND THE LIMITS OF
C**   EITHER THE TYPE OF CARGO L(I,2), OR FF
C
                IF(3.LT.LL(I,2) .OR. 3.GT.LU(I,2)) GO TO 51
                IF(L.LT.NFP(I)) GO TO 51
                AIJ(NEQ,LPX(I,J,5,L))= KARG(I,5,1)
                WRITE(13,04)NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1             NAME(I),MS(J),KG(5),L
                IF (LANS.EQ.0) GO TO 51
                PRINT 04,NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1             NAME(I),MS(J),KG(5),L
 51          CONTINUE
 50       CONTINUE
C**   FOR EACH TYPE OF UNIT
             DO 52 I=1,NUNITS+1
C
C**   FOR EACH MODE- VIA FRONT & APOD
C
                DO 53 M=1,3
                   IF(I.GT.IYP.AND.I.LE.NUNITS.AND.M.NE.2) GO TO 53
                   IF(LMT(1).LT.1.AND.IAB(I).EQ.0.AND.M.EQ.1) GO TO 53
                   IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 53
                   IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 53
                   IF(IAB(I).EQ.1.AND.M.NE.1) GO TO 53
C
C**   FOR EACH DEPLOYED UNIT BEFORE L
C
                   DO 55 IL=1,L-1
                      AIJ(NEQ,LPU(I,M,IL))= -NTON(I,5)*LP
                      WRITE(13,03)NEQ,LPU(I,M,IL),AIJ(NEQ,LPU(I,M,IL)),
```

```
     1                    UNAME(I),MD(M),IL
                       IF (LANS.EQ.0) GO TO 55
                       PRINT 03,NEQ,LPU(I,M,IL),AIJ(NEQ,LPU(I,M,IL)),
     1                    UNAME(I),MD(M),IL
 55                 CONTINUE
 53              CONTINUE
 52           CONTINUE
C
C**  THE EXCESS FOR THIS PERIOD
C
              AIJ(NEQ,LPS(1,5,L))= -1.0
                    WRITE(13,02)NEQ,LPS(1,5,L),AIJ(NEQ,LPS(1,5,L))
                    IF (LANS.EQ.0) GO TO 54
                    PRINT 02,NEQ,LPS(1,5,L),AIJ(NEQ,LPS(1,5,L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 54           IF(L.NE.1) AIJ(NEQ,LPS(1,5,L-1))= 1.0
              IF(L.EQ.1) GO TO 56
                    WRITE(13,02)NEQ,LPS(1,5,L-1),AIJ(NEQ,LPS(1,5,L-1))
                    IF (LANS.EQ.0) GO TO 56
                    PRINT 02,NEQ,LPS(1,5,L-1),AIJ(NEQ,LPS(1,5,L-1))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 56           RHS(NEQ)= 0.0
              WRITE(13,08)NEQ,RHS(NEQ)
              IF(LANS.EQ.0) GO TO 49
              PRINT 08,NEQ,RHS(NEQ)
C.....................................................................
 49    CONTINUE
C-5
C**  SET UP EQUATIONS FOR THE SHIPMENT
C**  OF SUPPLIES TO THE FRONT
C
       PRINT *,'-------------------------------------'
       PRINT *,'          FRONT    SUPPLIES'
       PRINT *,'-------------------------------------'
       WRITE(13,*)'-------------------------------------'
       WRITE(13,*)'          FRONT   SUPPLIES'
       WRITE(13,*)'-------------------------------------'
C**  FOR EACH PERIOD
       DO 59 L=2,NP
          NEQ=NEQ+1
C.....................................................................
C**  FOR EACH TYPE OF AIRCRAFT
          DO 60 I=1,NMAC
C
C**  FOR EACH MISSION EXCEPT APOD & INTRA DELIVERED
C
              DO 61 J=LL(I,1),LU(I,1)
                 IF(J.EQ.2) GO TO 61
                 IF(J.EQ.3) GO TO 61
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE CARGO
```

```
C**  LU(I,2), OR FP NFP(I)
C
               IF(3.LT.LL(I,2) .OR. 3.GT.LU(I,2)) GO TO 61
               IF(L.LT.NFP(I)) GO TO 61
               AIJ(NEQ,LPX(I,J,5,L))= KARG(I,5,1)
               WRITE(13,04)NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1            NAME(I),MS(J),KG(5),L
               IF (LANS.EQ.0) GO TO 61
               PRINT 04,NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1            NAME(I),MS(J),KG(5),L
 61          CONTINUE
 60       CONTINUE
C
C**  THE REQUIREMENT OF SUPPLIES FOR EACH TYPE OF UNIT AT
C**  THE FRONT (I=1...IYP     M=1,2,3; PERIOD=1...L-1)
C
          DO 62 I=1,NUNITS+1
             IF(I.GT.IYP.AND.I.LE.NUNITS) GO TO 62
             DO 65 M=1,3
                IF(LMT(1).LT.1.AND.IAB(I).EQ.0.AND.M.EQ.1) GO TO 65
                IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 65
                IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 65
                IF(IAB(I).EQ.1.AND.M.NE.1) GO TO 65
                DO 63 IL=1,L-1
                   AIJ(NEQ,LPU(I,M,IL))= -NTON(I,5)*LP
                   WRITE(13,03)NEQ,LPU(I,M,IL),AIJ(NEQ,LPU(I,M,IL)),
     1                UNAME(I),MD(M),IL
                   IF (LANS.EQ.0) GO TO 63
                   PRINT 03,NEQ,LPU(I,M,IL),AIJ(NEQ,LPU(I,M,IL)),
     1                UNAME(I),MD(M),IL
 63             CONTINUE
 65          CONTINUE
 62       CONTINUE
C
C**  CONSIDER THE SL RESTRICTION FOR TRUCKING
C
          AIJ(NEQ,LPSL(L))= 1.0
          WRITE(13,02)NEQ,LPSL(L),AIJ(NEQ,LPSL(L))
          IF(LANS.EQ.1) PRINT 02,NEQ,LPSL(L),AIJ(NEQ,LPSL(L))
C
C**  THE EXCESS FOR THIS PERIOD
C
          AIJ(NEQ,LPS(2,5,L))= -1.0
                WRITE(13,02)NEQ,LPS(2,5,L),AIJ(NEQ,LPS(2,5,L)
                IF (LANS.EQ.1) PRINT 02,NEQ,LPS(2,5,L),
     1             AIJ(NEQ,LPS(2,5,L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 64       IF(L.NE.1) AIJ(NEQ,LPS(2,5,L-1))= 1.0
          IF(L.EQ.1) GO TO 66
                WRITE(13,02)NEQ,LPS(2,5,L-1),AIJ(NEQ,LPS(2,5,L-1))
                IF (LANS.EQ.0) GO TO 66
                PRINT 02,NEQ,LPS(2,5,L-1),AIJ(NEQ,LPS(2,5,L-1))
C
```

```
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
C
 66         RHS(NEQ) = 0.0
            WRITE(13,03)NEQ,RHS(NEQ)
            IF(LANG.EQ.0) GO TO 59
            PRINT 03,NEQ,RHS(NEQ)
C..................................................................
 59    CONTINUE
C-6
C**  SET UP EQUATIONS FOR THE SHIPMENT
C**  OF SUPPLIES TO THE APOD
C
      PRINT *,'---------------------------------'
      PRINT *,'         APOD  SUPPLIES'
      PRINT *,'---------------------------------'
      WRITE(13,*)'---------------------------------'
      WRITE(13,*)'         APOD  SUPPLIES'
      WRITE(13,*)'---------------------------------'
C**  FOR EACH PERIOD
      DO 69 L=2,NP
         NEQ=NEQ+1
C...................................................................
C**  FOR EACH TYPE OF AIRCRAFT
         DO 70 I=1,NMAC
C
C**  FOR EACH APOD MISSION, J=2
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE
C**  TYPE OF MISSON LL(I,1), CARGO L(I,2), OR FP
C
              IF(2.LT.LL(I,1) .OR. 2.GT.LU(I,1)) GO TO 70
              IF(3.LT.LL(I,2) .OR. 3.GT.LU(I,2)) GO TO 70
              IF(L.LT.NFP(I)) GO TO 70
              AIJ(NEQ,LPX(I,2,5,L))= KARG(I,5,1)
              WRITE(13,04)NEQ,LPX(I,2,5,L),AIJ(NEQ,LPX(I,2,5,L)),
     :           NAME(I),MS(2),KG(5),L
              IF (LANG.EQ.0) GO TO 70
              PRINT 04,NEQ,LPX(I,2,5,L),AIJ(NEQ,LPX(I,2,5,L)),
     :           NAME(I),MS(2),KG(5),L
 70      CONTINUE
C
C**  FOR EACH TYPE OF UNIT AT THE APOD (IYP+1 TO NUNITS)
C
            DO 72 I=IYP+1,NUNITS
C
C**  FOR MODE- VIA APOD, M=2
C**  FOR EACH OF THE PREVIOUS PERIODS
C
              DO 73 IL=1,L-1
                 AIJ(NEQ,LPU(I,2,IL))= -NTON(I,5)*LF
                 WRITE(13,03)NEQ,LPU(I,2,IL),AIJ(NEQ,LPU(I,2,IL)),
     :              UNAME(I),MD(2),IL
                 IF (LANG.EQ.0) GO TO 73
                 PRINT 03,NEQ,LPU(I,2,IL),AIJ(NEQ,LPU(I,2,IL)),
     :              UNAME(I),MD(2),IL
 73           CONTINUE
```

```
      PRINT *,'---------------------------------'
      WRITE(13,*)'--------------------------------'
      WRITE(13,*)'     UNIT  LINKAGE  CEILING'
      WRITE(13,*)'--------------------------------'
      NEQ=NEQ+1
C.................................................................
C**  FOR ALL UNITS
          DO 190 I=1,NUNITS
C**  FOR EACH MODE
             DO 192 M=1,3
                IF(I.GT.IYP.AND.I.LE.NUNITS.AND.M.NE.2) GO TO 192
                   IF(LMT(1).LT.1.AND.IAB(I).EQ.0.AND.M.EQ.1) GO TO 192
                   IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 192
                   IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 192
                   IF(IAB(I).EQ.1.AND.M.NE.1) GO TO 192
C**  FOR ALL THE PERIODS
                DO 194 L=1,NP
                   AIJ(NEQ,LPU(I,M,L))= -NCI(I)
                   WRITE(13,08)NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1                UNAME(I),MD(M),L
                   IF (LANS.EQ.0) GO TO 194
                   PRINT 08,NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1                UNAME(I),MD(M),L
 194            CONTINUE
 192         CONTINUE
 190      CONTINUE
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
             RHS(NEQ)= 0.0
             WRITE(13,08)NEQ,RHS(NEQ)
             IF(LANS.EQ.0) GO TO 196
             PRINT 08,NEQ,RHS(NEQ)
C.................................................................
 196  CONTINUE
C-10
C**  EQUATIONS FOR UNIT LINKAGE CEILING
C
      PRINT *,'---------------------------------'
      PRINT *,'       UNIT  LINKAGE  FLOOR'
      PRINT *,'---------------------------------'
      WRITE(13,*)'--------------------------------'
      WRITE(13,*)'     UNIT  LINKAGE  FLOOR'
      WRITE(13,*)'--------------------------------'
      IF(NHQ(1).EQ.0) RETURN
      IF(NHQ(2).EQ.0) THEN
         NHQC=1
      ELSE
         NHQC=2
      END IF
      DO 197 K=1,NHQC
      NEQ=NEQ+1
C.................................................................
C**  FOR COMBAT AND HQ UNITS
          DO 198 I=NHQ(K)-1,NHQ(K)
C**  FOR EACH MODE
             DO 200 M=1,3
```

```
C
          IF(3.LT.LL(I,1) .OR. 3.GT.LU(I,1)) GO TO 182
          IF(3.LT.LL(I,2) .OR. 3.GT.LU(I,2)) GO TO 182
          COEF=KARG(I,5,1)
          AIJ(NEQ,LPX(I,3,5,L))= -COEF
          WRITE(13,04)NEQ,LPX(I,3,5,L),AIJ(NEQ,LPX(I,3,5,L)),
     1       NAME(I),MS(3),KG(5),L
          IF (LANS.EQ.0) GO TO 182
          PRINT 04,NEQ,LPX(I,3,5,L),AIJ(NEQ,LPX(I,3,5,L)),
     1       NAME(I),MS(3),KG(5),L
 182      CONTINUE
C
C**  FOR EACH TRANSPORTATION UNIT AT THE APOD
C
          DO 184 I=1,NUNITS
C
C**  FOR DELIVERY TO THE APOD (M=2) BUT TRUCKED TO THE FRONT
C
             IF(NTP(I).EQ.0) GO TO 184
C
C**  TIME TO TRAVEL FROM THE APOD TO THE FRONT=MY
C
             MY=NINT(DIST(2)/REAL(NTP(I)*LP))
             IF(MY.GT.L) GO TO 184
             DO 186 IL=1,L-MY
                COEF= NTP(I)*LP)/REAL(2*DIST(2))
                AIJ(NEQ,LPU(I,2,IL))= -COEF
                WRITE(13,03)NEQ,LPU(I,2,IL),AIJ(NEQ,LPU(I,2,IL)),
     1            UNAME(I),MD(2),IL
                IF (LANS.EQ.0) GO TO 186
             PRINT 03,NEQ,LPU(I,2,IL),AIJ(NEQ,LPU(I,2,IL)),
     1          UNAME(I),MD(2),IL
 186           CONTINUE
 184         CONTINUE
C
C**  CONSIDER THE SL RESTRICTION FOR TRUCKING
C
          AIJ(NEQ,LPSL(L))= 1.0
          WRITE(13,02)NEQ,LPSL(L),AIJ(NEQ,LPSL(L))
          IF (LANS.EQ.0) GO TO 188
          PRINT 02,NEQ,LPSL(L),AIJ(NEQ,LPSL(L))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 188      RHS(NEQ)= 0.0
          WRITE(13,08) NEQ,RHS(NEQ)
          IF(LANS.EQ.0) GO TO 190
          PRINT 08,NEQ,RHS(NEQ)
C...................................................................
 190   CONTINUE
C-?
C**  EQUATIONS FOR UNIT LINKAGE CEILING
C
      PRINT *,'-----------------------------------'
      PRINT *,'      UNIT  LINKAGE  CEILING'
```

```
C**    OF MISSON L(I,1) OR NFP
C
              IF(3.LT.LL(I,1) .OR. 3.GT.LU(I,1)) GO TO 174
              IF(L.LT.NFP(I)) GO TO 174
              DO 176 K=LL(I,2),LU(I,2)
                 AIJ(NEQ,LPX(I,3,K,L))= KARG(I,K,2)
                 WRITE(13,04)NEQ,LPX(I,3,K,L),AIJ(NEQ,LPX(I,3,K,L)),
     1              NAME(I),MS(3),KG(K),L
                 IF (LANS.EQ.0) GO TO 176
               PRINT 04,NEQ,LPX(I,3,K,L),AIJ(NEQ,LPX(I,3,K,L)),
     1           NAME(I),MS(3),KG(K),L
 176           CONTINUE
 174        CONTINUE
C**  FOR EACH TYPE OF UNIT
            DO 178 I=1,NUNITS+1
               J=3
                 IF(I.GT.IYP.AND.J.NE.2.AND.I.LE.NUNITS) GO TO 178
                 IF(IAB(I).EQ.1) GO TO 178
                 AIJ(NEQ,LPU(I,J,L))= -NTON(I,4)
                 WRITE(13,03)NEQ,LPU(I,J,L),AIJ(NEQ,LPU(I,J,L)),
     1              UNAME(I),MD(J),L
                 IF (LANS.EQ.0) GO TO 178
                 PRINT 03,NEQ,LPU(I,J,L),AIJ(NEQ,LPU(I,J,L)),
     1              UNAME(I),MD(J),L
 178        CONTINUE
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
            RHS(NEQ)= 0.0
            WRITE(13,08)NEQ,RHS(NEQ)
            IF(LANS.EQ.0) GO TO 166
            PRINT 08,NEQ,RHS(NEQ)
C......................................................................
 166   CONTINUE
C-8
C**  EQUATIONS FOR THE SHIPMENT OF SUPPLIES
C**  TO THE FRONT VIA THE APOD
C
      PRINT *,'---------------------------------'
      PRINT *,'   FRONT  SUPPLIES  -VIA  APOD'
      PRINT *,'---------------------------------'
      WRITE(13,*)'-------------------------------'
      WRITE(13,*)'  FRONT SUPPLIES -VIA APOD'
      WRITE(13,*)'-------------------------------'
C**  FOR EACH PERIOD
      DO 180 L=2,NP
         NEQ=NEQ+1
C......................................................................
C**  FOR EACH TYPE OF AIRCRAFT AVAILABLE
         DO 182 I=1,NMAC
            IF(L.LT.NFP(I)) GO TO 182
C
C**  FOR THE INTRATHEATER MISSIONS(J=3), WITH SUPPLIES(J=3).
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE
C**  TYPE OF MISSION L(I,1) OR CARGO L(I,2)
```

```
C
        DO 168 K=1,3
          NEQ=NEQ+1
C.......................................................................
C**  FOR EACH TYPE OF AIRCRAFT
C
          DO 170 I=1,NMAC
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE TYPE
C**    OF MISSON L(I,1), TYPE OF CARGO L(I,2), OR FP
C
                IF(3.LT.LL(I,1) .OR. 3.GT.LU(I,1)) GO TO 170
                IF(K.LT.LL(I,2) .OR. K.GT.LU(I,2)) GO TO 170
                IF(L.LT.NFP(I)) GO TO 170
                  AIJ(NEQ,LPX(I,3,K,L))= -KARG(I,K,1)
                  WRITE(13,04)NEQ,LPX(I,3,K,L),AIJ(NEQ,LPX(I,3,K,L)),
     1               NAME(I),MS(3),KG(K),L
                  IF (LANS.EQ.0) GO TO 170
                  PRINT 04,NEQ,LPX(I,3,K,L),AIJ(NEQ,LPX(I,3,K,L)),
     1               NAME(I),MS(3),KG(K),L
 170          CONTINUE
C
C**  FOR EACH TYPE OF UNIT SHIPPED TO THE APOD, J=2 FOR THOSE REMAINING
C**  AT THE APOD OR WALKING TO THE FRONT, J=3 FOR THOSE UNITS DEPLOYED
C**  TO THE FRONT BUT FLYING INTRATHEATER AIRLIFT
C
          DO 172 I=1,NUNITS+1
             J=3
                IF(I.GT.IYP.AND.J.NE.2.AND.I.LE.NUNITS) GO TO 172
                IF(IAB(I).EQ.1) GO TO 172
                AIJ(NEQ,LPU(I,J,L))= NTON(I,K)
                WRITE(13,03)NEQ,LPU(I,J,L),AIJ(NEQ,LPU(I,J,L)),
     1             UNAME(I),MD(J),L
                IF (LANS.EQ.0) GO TO 172
                PRINT 03,NEQ,LPU(I,J,L),AIJ(NEQ,LPU(I,J,L)),
     1             UNAME(I),MD(J),L
 172          CONTINUE
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
          RHS(NEQ)= 0.0
          WRITE(13,08)NEQ,RHS(NEQ)
          IF(LANS.EQ.0) GO TO 168
          PRINT 08,NEQ,RHS(NEQ)
C.......................................................................
 168      CONTINUE
C
C**  FOR PASSENGERS
C
      NEQ=NEQ+1
C.......................................................................
C**  FOR EACH TYPE OF AIRCRAFT
          DO 174 I=1,NMAC
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF EITHER THE TYPE
```

```
               PRINT 08,NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1            UNAME(I),MD(M),L
 158           CONTINUE
 156        CONTINUE
            RHS(NEQ)=NUNT(I)
            WRITE(13,08)NEQ,RHS(NEQ)
            IF (LANS.EQ.0) GO TO 154
            PRINT 08,NEQ,RHS(NEQ)
C.......................................................................
 154    CONTINUE
C
C**  FOR EACH ALOC UNIT
C
         NEQ=NEQ+1
         DO 159 I=NUNITS,NUNITS+1
C.......................................................................
C**  FOR EACH MODE
            DO 160 M=1,3
                  IF(I.GT.IYP.AND.I.LE.NUNITS.AND.M.NE.2) GO TO 160
                     IF(LMT(1).LT.1.AND.IAB(I).EQ.0.AND.M.EQ.1) GO TO 160
                     IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 160
                     IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 160
C**  FOR EACH PERIOD
               DO 162 L=1,NP
                  AIJ(NEQ,LPU(I,M,L))=1.0
                  WRITE(13,03)NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1               UNAME(I),MD(M),L
                  IF (LANS.EQ.0) GO TO 162
                  PRINT 03,NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1               UNAME(I),MD(M),L
 162           CONTINUE
 160        CONTINUE
 159        CONTINUE
            RHS(NEQ)=NUNT(NUNITS)
            WRITE(13,08)NEQ,RHS(NEQ)
            IF (LANS.EQ.0) GO TO 164
            PRINT 08,NEQ,RHS(NEQ)
C.......................................................................
C
C**  INEQUALITY FOR THE SHIPMENT OF UNITS FROM THE APOD TO THE FRONT.
C**  THIS INSURES THAT WHAT IS SHIPPED TO THE FRONT DOES NOT EXCEED
C**  WHAT IS AVAILABLE TO BE SHIPPED AT THE APOD.
C
 164  PRINT *,'---------------------------------'
      PRINT *,' UNIT SHIPMENT FROM APOD TO FRONT'
      PRINT *,'---------------------------------'
      WRITE(13,*)'---------------------------------'
      WRITE(13,*)' UNIT SHIPMENT FROM APOD TO FRONT'
      WRITE(13,*)'---------------------------------'
C
C**  FOR EACH PERIOD
C
      DO 166 L=1,NP
C
C**  FOR OUT, OVER, AND BULK CARGO
```

```
 150      CONTINUE
C
C**  IF WALK TO THE FRONT (M=2), CONSIDER TIME DISTANCE RELATIONSHIP TO
C**  GET TO THE FRONT FROM THE APOD
C
        M=2
        IF(NTV(I).EQ.0) GO TO 151
        MY=INT((DIST(2))/REAL(NTV(I)*LP))
        IF(MY.GT.L) GO TO 151
        DO 153 IL=1,L-MY
             COEF=NPAL*LP
           AIJ(NEQ,LPU(I,M,IL))= -COEF
           WRITE(13,03)NEQ,LPU(I,M,IL),AIJ(NEQ,LPU(I,M,IL)),
     1       UNAME(I),MD(M),IL
           IF (LANS.EQ.0) GO TO 153
           PRINT 03,NEQ,LPU(I,M,IL),AIJ(NEQ,LPU(I,M,IL)),
     1       UNAME(I),MD(M),IL
 153      CONTINUE
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 151      RHS(NEQ)= NHA(1)
        WRITE(13,08)NEQ,RHS(NEQ)
        IF(LANS.EQ.0) GO TO 142
        PRINT 08,NEQ,RHS(NEQ)
C.....................................................................
 142   CONTINUE
C-6
C**  SET UP EQUATIONS FOR THE ARMY UNITS  ****
C
      PRINT *,'----------------------------------'
      PRINT *,'          DEPLOYED  UNITS'
      PRINT *,'----------------------------------'
      WRITE(13,*)'-------------------------------'
      WRITE(13,*)'       DEPLOYED  UNITS'
      WRITE(13,*)'-------------------------------'
C
C**  FOR EACH UNIT EXCEPT THE ALCE UNITS
C
      DO 154 I=1,NUNITS-1
         NEQ=NEQ+1
C.....................................................................
C**  FOR EACH MODE
        DO 156 M=1,3
             IF(I.GT.IYP.AND.I.LE.NUNITS.AND.M.NE.2) GO TO 156
               IF(LMT(1).LT.1.AND.IAB(I).EQ.0.AND.M.EQ.1) GO TO 156
               IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 156
               IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 156
               IF(IAB(I).EQ.1.AND.M.NE.1) GO TO 156
C**  FOR EACH PERIOD
          DO 158 L=1,NP
             AIJ(NEQ,LPU(I,M,L))=1.0
             WRITE(13,03)NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1          UNAME(I),MD(M),L
             IF (LANS.EQ.0) GO TO 158
```

```
C**  FOR EACH MISSION TO THE FRONT, DIRECT (J=1) AND INTRA (J=3)
C
              DO 146 J=1,3,2
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF
C**  THE TYPE OF MISSION L(I,1)
C
                IF(J.LT.LL(I,1) .OR. J.GT.LU(I,1)) GO TO 146
                DO 148 K=LL(I,2),LU(I,2)
                  COEF=EAS(I,K)*MHE(I)
                  AIJ(NEQ,LPX(I,J,K,L))= COEF
                  WRITE(13,04)NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1              NAME(I),MS(J),KG(K),L
                  IF (LANS.EQ.0) GO TO 149
                  PRINT 04,NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1              NAME(I),MS(J),KG(K),L
C
C**  CONSIDER SUPPLY CARGO IF BULK CARGO IS CONSIDERED
C
 149              IF(K.EQ.3) THEN
                    AIJ(NEQ,LPX(I,J,5,L))=COEF
                    WRITE(13,04)NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1                NAME(I),MS(J),KG(5),L
                    IF(LANS.EQ.0) GO TO 148
                  ELSE
                    GO TO 148
                  END IF
                 PRINT 04,NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1             NAME(I),MS(J),KG(5),L
 148             CONTINUE
 146           CONTINUE
 144         CONTINUE
C
C**  FOR THE ALCE UNIT AT THE FRONT
C
          I=NUNITS+1
C
C**  FOR EACH MEANS OF GETTING TO THE FRONT: 1- DIRECT
C**       AND 3- APOD & FLY TO THE FRONT
C
        DO 150 M=1,3,2
          IF(LMT(1).LT.1.AND.M.EQ.1) GO TO 150
          DO 152 IL=1,L
            IF(IL.EQ.L) THEN
              COEF=NPAL*LP*0.5
            ELSE
              COEF=NPAL*LP
            END IF
            AIJ(NEQ,LPU(I,M,IL))= -COEF
            WRITE(13,03)NEQ,LPU(I,M,IL),AIJ(NEQ,LPU(I,M,IL)),
     1        UNAME(I),MD(M),IL
            IF (LANS.EQ.0) GO TO 152
            PRINT 03,NEQ,LPU(I,M,IL),AIJ(NEQ,LPU(I,M,IL)),
     1        UNAME(I),MD(M),IL
 152      CONTINUE
```

```
                ELSE
                  GO TO 138
                END IF
              PRINT 04,NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1          NAME(I),MS(J),KG(5),L
 138          CONTINUE
 136        CONTINUE
 134      CONTINUE
C
C**  FOR THE ALCE UNIT(LAST TERM IN THE FILE)=NUNITS
C
        I=NUNITS
C
C**  FOR THE APOD MODE=2
C**  FOR ALL PREVIOUS AND NEWLY DEPLOYED ALCE UNITS
C
        DO 140 IL=1,L
          IF(IL.EQ.L) THEN
            COEF=NPAL*LP*0.5
          ELSE
            COEF=NPAL*LP
          END IF
          AIJ(NEQ,LPU(I,2,IL))= -COEF
          WRITE(13,03)NEQ,LPU(I,2,IL),AIJ(NEQ,LPU(I,2,IL)),
     1      UNAME(I),MD(2),IL
          IF (LANS.EQ.0) GO TO 140
          PRINT 03,NEQ,LPU(I,2,IL),AIJ(NEQ,LPU(I,2,IL)),
     1      UNAME(I),MD(2),IL
 140    CONTINUE
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
        RHS(NEQ)= NHA(2)
        WRITE(13,08)NEQ,RHS(NEQ)
        IF(LANS.EQ.0) GO TO 132
        PRINT 08,NEQ,RHS(NEQ)
C...................................................................
 132  CONTINUE
C
C**  EQUATIONS FOR THE MHE LIMITATION AT FRONT
C-5
      PRINT *,'---------------------------------'
      PRINT *,'      MHE  LIMITATION-FRONT'
      PRINT *,'---------------------------------'
      WRITE(13,*)'-----------------------------'
      WRITE(13,*)'      MHE  LIMITATION-FRONT'
      WRITE(13,*)'-----------------------------'
C**  FOR EACH PERIOD
      DO 142 L=1,NP
        NEQ=NEQ+1
C...................................................................
C**  FOR EACH TYPE OF AIRCRAFT AVAILABLE
        DO 144 I=1,NMAC
          IF(L.LT.NFP(I)) GO TO 144
C
```

```
            COEF=REAL(10000*NTAC(I))/REAL(LP*NPK(I))
            AIJ(NEQ,LPU(I,2,L))=COEF
            WRITE(13,03)NEQ,LPU(I,2,L),AIJ(NEQ,LPU(I,2,L)),
     1         UNAME(I),MD(2),L
            IF(LANS.EQ.0) GO TO 130
            PRINT 03,NEQ,LPU(I,2,L),AIJ(NEQ,LPU(I,2,L)),
     1         UNAME(I),MD(2),L
 130      CONTINUE
          RHS(NEQ)=10000
          WRITE(13,08)NEQ,RHS(NEQ)
          IF (LANS.EQ.0) GO TO 122
          PRINT 08,NEQ,RHS(NEQ)
C...................................................................
 122    CONTINUE
C-4
C**  EQUATIONS FOR THE MHE LIMITATION AT APOD
C
      PRINT *,'----------------------------------'
      PRINT *,'         MHE  LIMITATION-APOD'
      PRINT *,'----------------------------------'
      WRITE(13,*)'-------------------------------'
      WRITE(13,*)'        MHE LIMITATION-APOD'
      WRITE(13,*)'-------------------------------'
C**  FOR EACH PERIOD
      DO 132 L=1,NP
         NEQ=NEQ+1
C...................................................................
C**  FOR EACH TYPE OF AIRCRAFT AVAILABLE
         DO 134 I=1,NMAC
            IF(L.LT.NFP(I)) GO TO 134
C
C**  FOR EACH MISSION INTO THE APOD(J=2,3)
C
            DO 136 J=2,3
C
C**  CHECK TO SEE IF BEYOND THE LIMITS OF
C**  THE TYPE OF MISSION L(I,1)
C
               IF(J.LT.LL(I,1) .OR. J.GT.LU(I,1)) GO TO 136
               DO 138 K=LL(I,2),LU(I,2)
                  COEF=EAS(I,K)*MHE(I)
                  AIJ(NEQ,LPX(I,J,K,L))= COEF
                  WRITE(13,04)NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1               NAME(I),MS(J),KG(K),L
                  IF (LANS.EQ.0) GO TO 139
                  PRINT 04,NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1               NAME(I),MS(J),KG(K),L
C
C**  CONSIDER SUPPLY CARGO IF BULK CARGO IS CONSIDERED
C
 139              IF(K.EQ.3) THEN
                    AIJ(NEQ,LPX(I,J,5,L))=COEF
                    WRITE(13,04)NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1                 NAME(I),MS(J),KG(5),L
                    IF(LANS.EQ.0) GO TO 138
```

```
            RHS(NEQ)=(1000*NAC(I)*AVAIL(I)*KTS(I)*LP)/REAL(2*DIST(I))
            WRITE(13,08)NEQ,RHS(NEQ)
            IF (LANS.EQ.0) GO TO 112
            PRINT 08,NEQ,RHS(NEQ)
C.................................................................
 112       CONTINUE
 110    CONTINUE
C-3
C**  SET UP EQUATIONS FOR THE AIRPORT LIMITATIONS
C
       PRINT *,'-----------------------------------'
       PRINT *,'        AIRPORT  LIMITATIONS'
       PRINT *,'-----------------------------------'
       WRITE(13,*)'-------------------------------'
       WRITE(13,*)'      AIRPORT  LIMITATIONS'
       WRITE(13,*)'-------------------------------'
C**  FOR EACH PERIOD
       DO 122 L=1,NP
          NEQ=NEQ+1
C.................................................................
C**  FOR EACH MAC TYPE AIRCRAFT
C
          DO 124 I=1,NMAC
             IF (L.LT.NFP(I)) GO TO 124
C
C**  FOR EACH MISSION TRANSITING THE APOD (J=2,3)
C
             DO 126 J=2,3
                IF(J.LT.LL(I,1).OR.J.GT.LU(I,1)) GO TO 126
                COEF=10000*GT(I)/REAL(NPRK(I)*24*LP)
                DO 128 K=LL(I,2),LU(I,2)
                   AIJ(NEQ,LPX(I,J,K,L))=COEF
                   WRITE(13,04)NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1                NAME(I),MS(J),KG(K),L
                   IF (LANS.EQ.0) GO TO 129
                   PRINT 04,NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1                NAME(I),MS(J),KG(K),L
 129               IF(K.EQ.3) THEN
                     AIJ(NEQ,LPX(I,J,5,L))=COEF
                     WRITE(13,04)NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1               NAME(I),MS(J),KG(5),L
                      IF(LANS.EQ.0) GO TO 128
                   ELSE
                     GO TO 128
                   END IF
                   PRINT 04,NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1                NAME(I),MS(J),KG(5),L
 128            CONTINUE
 126         CONTINUE
 124      CONTINUE
C
C**  FOR EACH FIGHTER TYPE AC AT THE APOD
C
          DO 130 I=1,NUNITS
             IF(NTAC(I).EQ.0) GO TO 130
```

```
                COEF=1000/(UTE(I,J))
                DO 116 K=LL(I,2),LU(I,2)
                   AIJ(NEQ,LPX(I,J,K,L))=COEF
                   WRITE(13,04)NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1                NAME(I),MS(J),KG(K),L
                   IF (LANS.EQ.0) GO TO 117
                   PRINT 04,NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1                NAME(I),MS(J),KG(K),L
C
C**  CONSIDER SUPPLY CARGO IF BULK CARGO IS CONSIDERED
C
 117         IF(K.EQ.3) THEN
                AIJ(NEQ,LPX(I,J,5,L))=COEF
                WRITE(13,04)NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1             NAME(I),MS(J),KG(5),L
                   IF(LANS.EQ.0) GO TO 116
                ELSE
                   GO TO 116
                END IF
                PRINT 04,NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1             NAME(I),MS(J),KG(5),L
 116            CONTINUE
 114          CONTINUE
C
C**  FOR THE INTRATHEATER MISSIONS
C**   CHECK FOR MS OUT OF LIMITS AND AC THAT SPECIALIZE IN INTRA(LL=3)
C
             IF(LL(I,1).GT.3 .OR.LU(I,1).LT.3) GO TO 118
             IF(LL(I,1).NE.3) COEF=(1000*DIST(2))/(DIST(1)*UTE(I,3))
             IF(LL(I,1).EQ.3) COEF=(1000/UTE(I,3))
                DO 120 K=LL(I,2),LU(I,2)
                   AIJ(NEQ,LPX(I,3,K,L))=COEF
                   WRITE(13,04)NEQ,LPX(I,3,K,L),AIJ(NEQ,LPX(I,3,K,L)),
     1                NAME(I),MS(3),KG(K),L
                   IF (LANS.EQ.0) GO TO 121
                   PRINT 04,NEQ,LPX(I,3,K,L),AIJ(NEQ,LPX(I,3,K,L)),
     1                NAME(I),MS(3),KG(K),L
C
C**  CONSIDER SUPPLY CARGO IF BULK CARGO IS CONSIDERED
C
 121               IF(K.EQ.3) THEN
                     AIJ(NEQ,LPX(I,3,5,L))=COEF
                     WRITE(13,04)NEQ,LPX(I,3,5,L),AIJ(NEQ,LPX(I,3,5,L)),
     1                  NAME(I),MS(3),KG(5),L
                     IF(LANS.EQ.0) GO TO 120
                   ELSE
                     GO TO 120
                   END IF
                 PRINT 04,NEQ,LPX(I,3,5,L),AIJ(NEQ,LPX(I,3,5,L)),
     1             NAME(I),MS(3),KG(5),L
 120             CONTINUE
 118          CONTINUE
C
C**  INSERT THE RHS OF THE CONSTRAINT
C
```

```
C
      SUBROUTINE CONSTR(ATTR)
C
C**
C**  THIS BUILDS THE FOLLOWING INEQUALITY CONSTRAINTS INTO THE AIJ MATRIX
C**       2.  AIRCRAFT UTE RATE
C**       3.  AIRPORT LIMITATIONS
C**       4.  MHE LIMITATIONS AT THE APOD
C**       5.  MHE LIMITATIONS AT THE FRONT
C**       6.  POSSIBLE NUMBER OF DEPLOYED UNITS
C**       7.  INTRATHEATER SHIPMENT OF UNITS FROM THE APOD TO THE FRONT
C**       8.  INTRATHEATER SHIPMENT OF SUPPLIES FROM THE APOD TO THE FRONT
C**       9.  UNIT LINKAGE CEILING
C**      10.  UNIT LINKAGE FLOOR
C**
C
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**  CHECK TO SEE IF ECHO DESIRED
C
*     PRINT *,'ECHO ON THE #1 PRIORITY CONSTRAINTS?(1=Y/0=N).'
*     READ *,LANS
      LANS=0
      PRINT *,'-----------------------------------------------------------'
      PRINT *,'              INEQUALITY  CONSTRAINTS  [ <= ]'
      PRINT *,'-----------------------------------------------------------'
C-2
C**  SET UP EQUATIONS FOR THE AIRCRAFT UTE RATE  **
C
      PRINT *,'-----------------------------------'
      PRINT *,'       AIRCRAFT  UTE  RATE'
      PRINT *,'-----------------------------------'
      WRITE(13,*)'-----------------------------------'
      WRITE(13,*)'       AIRCRAFT  UTE  RATE'
      WRITE(13,*)'-----------------------------------'
C**  FOR EACH TYPE OF AIRCRAFT
      DO 110 I=1,NMAC
C**  FOR EACH PERIOD
         DO 112 L=NFP(I),NP
            NEQ=NEQ+1
C..........................................................................
C**  FOR THE INTERTHEATER MISSIONS
            DO 114 J=LL(I,1),LU(I,1)
               IF (J.EQ.3) GO TO 114
```

```
     1                NAME(I),MS(J),KG(K),L
C
C**  CONSIDER SUPPLY CARGO IF BULK CARGO IS CONSIDERED
C
 87         IF(K.EQ.3) THEN
              AIJ(NEQ,LPX(I,J,5,L))=KARG(I,5,1)
              WRITE(13,04)NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1          NAME(I),MS(J),KG(5),L
                IF(LANS.EQ.0) GO TO 85
            ELSE
              GO TO 85
            END IF
              PRINT 04,NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1          NAME(I),MS(J),KG(5),L
 85           CONTINUE
 83          CONTINUE
 82       CONTINUE
C
C**  THE EXCESS FOR THIS PERIOD
C
          AIJ(NEQ,LPR(L))= -1.0
          WRITE(13,02)NEQ,LPR(L),AIJ(NEQ,LPR(L))
          IF (LANS.EQ.0) GO TO 84
          PRINT 02,NEQ,LPR(L),AIJ(NEQ,LPR(L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 84       IF(L.NE.1) AIJ(NEQ,LPR(L-1))= 1.0
          IF(L.EQ.1) GO TO 86
          WRITE(13,02)NEQ,LPR(L-1),AIJ(NEQ,LPR(L-1))
          IF (LANS.EQ.0) GO TO 86
          PRINT 02,NEQ,LPR(L-1),AIJ(NEQ,LPR(L-1))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 86       RHS(NEQ)= RC*LP
          WRITE(13,08)NEQ,RHS(NEQ)
          IF(LANS.EQ.0) GO TO 80
          PRINT 08,NEQ,RHS(NEQ)
C.......................................................................
 80    CONTINUE
C
       NCR=NEQ
       WRITE(13,*)'NCR=',NCR
C
C**  FORMAT STATEMENTS
C
 02    FORMAT('AIJ(',2I4,')=',F14.5)
 03    FORMAT('AIJ(',2I4,')=',F14.5,5X,A14,2X,A5,I3)
 04    FORMAT('AIJ(',2I4,')=',F14.5,5X,A6,2X,A5,2X,A4,I3)
 08    FORMAT ('RHS(',I4,')=',F14.5,/,'------------------------------')
C
C
       END
C***********************************************************************
```

```
 72         CONTINUE
C
C**  CONSIDER THE SL RESTRICTION FOR TRUCKING
C
            AIJ(NEQ,LPSL(L))= -1.0
            WRITE(13,02)NEQ,LPSL(L),AIJ(NEQ,LPSL(L))
            IF(LANS.EQ.1) PRINT 02,NEQ,LPSL(L),AIJ(NEQ,LPSL(L))
C
C**  THE EXCESS FOR THIS PERIOD
C
            AIJ(NEQ,LPS(3,5,L))= -1.0
                  WRITE(13,02)NEQ,LPS(3,5,L),AIJ(NEQ,LPS(3,5,L))
                  IF (LANS.EQ.0) GO TO 74
                  PRINT 02,NEQ,LPS(3,5,L),AIJ(NEQ,LPS(3,5,L))
C
C**  THE EXCESS FROM THE PREVIOUS PERIOD
C
 74         IF(L.NE.1) AIJ(NEQ,LPS(3,5,L-1))= 1.0
            IF(L.EQ.1) GO TO 76
                  WRITE(13,02)NEQ,LPS(3,5,L-1),AIJ(NEQ,LPS(3,5,L-1))
                  IF (LANS.EQ.0) GO TO 76
                  PRINT 02,NEQ,LPS(3,5,L-1),AIJ(NEQ,LPS(3,5,L-1))
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
 76         RHS(NEQ)= 0.0
            WRITE(13,08)NEQ,RHS(NEQ)
            IF(LANS.EQ.0) GO TO 69
            PRINT 08,NEQ,RHS(NEQ)
C....................................................................
 69   CONTINUE
C
C**  EQUATIONS FOR UNIT ABILITITIES
C
      PRINT *,'----------------------------------'
      PRINT *,'        RIGGER  CONSTRAINT'
      PRINT *,'----------------------------------'
      WRITE(13,*)'----------------------------------'
      WRITE(13,*)'       RIGGER  CONSTRAINT'
      WRITE(13,*)'----------------------------------'
C**  FOR EACH PERIOD
      DO 80 L=1,NP
         NEQ=NEQ+1
C....................................................................
         DO 82 I=1,NMAC
             DO 83 J=LL(I,1),LU(I,1)
              IF(J.NE.4) GO TO 83
                DO 85 K=LL(I,2),LU(I,2)
                  IF(K.EQ.4) GO TO 85
                  IF(L.LT.NFP(I)) GO TO 85
                  AIJ(NEQ,LPX(I,J,K,L))= KARG(I,K,1)
                  WRITE(13,04)NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1               NAME(I),MS(J),KG(K),L
                  IF (LANS.EQ.0) GO TO 87
                  PRINT 04,NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
```

```
             IF(IAB(I).EQ.1.AND.M.NE.1) GO TO 200
C**  FOR ALL THE PERIODS
             DO 202 L=1,NP
               IF(I.EQ.1) COEF=1
               IF(I.EQ.2) COEF=-3
               AIJ(NEQ,LPU(I,M,L))= COEF
               WRITE(13,03)NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1            UNAME(I),MD(M),L
               IF (LANS.EQ.0) GO TO 202
               PRINT 03,NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1            UNAME(I),MD(M),L
 202         CONTINUE
 200       CONTINUE
 198     CONTINUE
 197   CONTINUE
C
C**  INPUT THE RIGHT HAND SIDE OF THE EQUATION
C
           RHS(NEQ)= 2.0
           WRITE(13,08)NEQ,RHS(NEQ)
           IF(LANS.EQ.0) GO TO 204
           PRINT 08,NEQ,RHS(NEQ)
C......................................................................
 204   CONTINUE
C
C**  FORMAT STATEMENTS
C
 02    FORMAT('AIJ(',2I4,')=',F14.5)
 03    FORMAT('AIJ(',2I4,')=',F14.5,5X,A14,2X,A5,I3)
 04    FORMAT('AIJ(',2I4,')=',F14.5,5X,A6,2X,A5,2X,A4,I3)
 08    FORMAT ('RHS(',I4,')=',F14.5,/,'------------------------------')
C
C
       LANS=0
       RETURN
       END
C*********************************************************************
C**
       SUBROUTINE SORTIE
C
C**  THIS BUILDS THE CONSTRAINTS FOR THE NUMBER OF POSSIBLE AIRCRAFT
C**  SORTIES POSSIBLE.
C
       CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14,FNAME*6
       CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
       COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
       COMMON/AFD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
       COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
       COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
       LANS=0
```

```
C**  SET UP EQUATIONS FOR THE AIRCRAFT SORTIES
C
      NC(2)=0
      PRINT *,'--------------------------------'
      PRINT *,'       AIRCRAFT  SORTIES'
      PRINT *,'--------------------------------'
      WRITE(13,*)'--------------------------------'
      WRITE(13,*)'     AIRCRAFT  SORTIES'
      WRITE(13,*)'--------------------------------'
C
C**  FOR EACH TYPE OF AIRCRAFT
C
      DO 100 I=1,NMAC
C
C**  FOR EACH PERIOD
C
         DO 102 L=NFP(I),NP
            NEQ=NEQ+1
             NC(2)=NC(2)+1
C.....................................................................
            DO 104 J=LL(I,1),LU(I,1)
C
C**  FOR THE INTERTHEATER MISSIONS
C
               IF (J.NE.3) THEN
                  COEF=TINTER(I)
C
C**  FOR THE INTRATHEATER MISSIONS
C
               ELSE IF(J.EQ.3) THEN
                  COEF=TINTRA(I)
               END IF
               DO 106 K=LL(I,2),LU(I,2)
                  AIJ(NEQ,LPX(I,J,K,L))=COEF
                  WRITE(13,04)NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1               NAME(I),MS(J),KG(K),L
                  IF (LANS.EQ.0) GO TO 107
                  PRINT 04,NEQ,LPX(I,J,K,L),AIJ(NEQ,LPX(I,J,K,L)),
     1               NAME(I),MS(J),KG(K),L
C
C**  CONSIDER THE SUPPLY CARGO IF BULK IS CONSIDERED
C
 107           IF(K.EQ.3) THEN
                  AIJ(NEQ,LPX(I,J,5,L))=COEF
                  WRITE(13,04)NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1               NAME(I),MS(J),KG(5),L
                  IF(LANS.EQ.0) GO TO 106
               ELSE
                 GO TO 106
               END IF
               PRINT 04,NEQ,LPX(I,J,5,L),AIJ(NEQ,LPX(I,J,5,L)),
     1            NAME(I),MS(J),KG(5),L
 106            CONTINUE
 104           CONTINUE
C**  INPUT THE RHS
```

```
          RHS(NEQ)=NAC(I)*AVAIL(I)*LP
          WRITE(13,08)NEQ,RHS(NEQ)
          IF (LANS.EQ.0) GO TO 102
          PRINT 08,NEQ,RHS(NEQ)
C.....................................................................
 102       CONTINUE
 100    CONTINUE
C
C**   FORMAT STATEMENTS
C
 04     FORMAT('AIJ(',2I4,')=',F14.5,3X,A6,2X,A5,2X,A4,I3)
 08     FORMAT ('RHS(',I4,')=',F14.5,/,'-------------------------------')
C
C
      RETURN
      END
C*********************************************************************
C** 8
      SUBROUTINE MGOAL
C
C**   MAKES THE GOALS DESIRED BY THE USER
C
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*16,FNAME*6
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
C**   PRINT OUT THE INFORMATION NEEDED FOR THIS FILE
C
      PRINT 5
      PRINT *,' THE FOLLOWING DATA IS NEEDED TO ESTABLISH THE GOALS'
      PRINT *,'-----------------------------------------------------'
      PRINT *
      PRINT *,'1.  PRIORITY NUMBER (2 THROUGH 9, INTEGER)'
      PRINT *
      PRINT *,'2.  TYPE OF GOAL, FROM ONE OF THE FOLLOWING:'
      PRINT *,'      A.  FRONT LINE TRACE DISTANCE'
      PRINT *,'      B.  ANTI-TANK STRENGTH'
      PRINT *,'      C.  FIREPOWER'
      PRINT *,'      D.  DEPLOYMENT OF AN ARMY UNIT'
      PRINT *
      PRINT *,'3.  SPECIFIED AMOUNT OF THE TYPE GOAL (REAL)'
      PRINT *
      PRINT *,'4.  PERIOD COMPLETION DESIRED (INTEGER)'
      PRINT *
      PRINT *,'IF YOU DO NOT HAVE ALL THE ABOVE DATA, YOU MAY TERMINATE
     COR CONTINUE.'
```

```
      PRINT *,'DO YOU WANT TO CONTINUE? (1=Y,0=N)'
 10   READ *,NRES
      IF(NRES.GT.1.OR.NRES.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 10
      END IF
      IF(NRES.EQ.0) STOP
C
C**  INPUT THE GOAL NAMES
C
        GNAME(1)='FRONT LINE TRACE'
        GNAME(2)='ANTI-TANK POWER'
        GNAME(3)='FIREPOWER'
C
C** START THE INPUT PROCESS
C
      I=1
 12   PRINT 5
      I=I+1
      PRINT *,'SELECT THE GOAL TYPE FOR PRIORITY ',I
      K=IYP+3
      DO 18 J=1,K
         IF(J.LE.3) PRINT 9,J,GNAME(J)
         IF(J.GT.3) PRINT 9,J,UNAME(J-3)
18    CONTINUE
      PRINT *,'** IF FINISHED TYPE 0'
19    READ *,GLS(I,1)
      IF(GLS(I,1).EQ.0) GO TO 20
      IF(GLS(I,1).GT.K.OR.GLS(I,1).LT.1) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE RE-ENTER.'
         GO TO 19
      END IF
      NC(I)=1
      NPRIT=I
      PRINT *,'ENTER THE DESIRED OBJECTIVE OF THE PRIORITY.'
      READ *,GLS(I,2)
      PRINT *,'ENTER THE PERIOD COMPLETION DESIRED.'
      READ *,GLS(I,3)
C
C**  CHECK TO SEE IF THERE IS MEMORY FOR MORE GOALS
C
      IF(I.EQ.8) PRINT *,'***  YOU HAVE MEMORY FOR ONLY ONE MORE GOAL.'
      IF(I.EQ.9) THEN
         PRINT *,'YOU ARE OUT OF MEMORY FOR GOALS.'
         GO TO 20
      END IF
      GO TO 12
C
C**  ASK IF THE FILE IS TO BE VIEWED
C
 20   PRINT *,'DO YOU WANT TO SEE THE LIST OF GOALS? (1=Y/0=N)'
 21   READ *,IVU
      IF(IVU.GT.1.OR.IVU.LT.0) THEN
         PRINT *,'NOT A VALID REPLY, PLEASE ENTER (1=Y/0=N).'
         GO TO 21
```

```
      END IF
C
C**  PRINT OUT THE FILE IF IVU = 1
C
      IF(IVU.EQ.1) THEN
      DO 24 J=2,NPRIT
         IF(GLS(J,1).GT.3) THEN
            K=INT(GLS(J,1)-3)
            L=INT(GLS(J,3))
            PRINT 25,J,GLS(J,2),UNAME(K),L
            GO TO 24
         ELSE
            K=INT(GLS(J,1))
            L=INT(GLS(J,3))
            PRINT 25,J,GLS(J,2),GNAME(K),L
         END IF
 24   CONTINUE
      END IF
C
C**  SET UP THE NUMBER OF CONSTRAINTS FOR EACH GOAL AND THE NUMBER
C**  OF GOALS
C
      DO 40 I=1,NG
        NC(I)=1
 40   CONTINUE
C
C**  FORMAT STATEMENTS
C
 2    FORMAT(A6)
 5    FORMAT(//////////////////////////)
 9    FORMAT(' -- ',I2,2X,A16)
 25   FORMAT('GOAL #',I2,' IS ',F5.1,' OF ',A16,' BY PERIOD',I2)
C
      RETURN
      END
C*********************************************************************
C S7
      SUBROUTINE GOALS(IDP,OBJ,ITYPE,LANS)
C
C**  THIS SETS UP THE GOALS
C
      REAL OBJ
      CHARACTER NAME(10)*6,UNAME(11)*14,GNAME(3)*14
      CHARACTER MS(4)*5,KG(5)*4,MD(3)*5
      COMMON/ACF/NMAC,NAC(10),AVAIL(10),UTE(10,4),KARG(10,5,2),KTS(10),
     C   GT(10),MHE(10),NFP(10),NPRK(10)
      COMMON/APD/DIST(2),TINTER(10),TINTRA(10),EAS(10,4),CPI(4),
     C   NHA(2),NPAL,RC,GLS(9,3)
      COMMON/ARM/NUNITS,NUNT(10),NTON(11,5),NFP(10),NAT(10),NFT(10),
     C   NTAC(10),NPK(10),NTP(11),NTV(11),IAB(10),NCI(10),IYP,NHQ(2)
      COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
      COMMON/CHR/NAME,UNAME,GNAME,MS,KG,MD
C
```

```
C**  GO TO THE PROPER TYPE
C
      IF(IDP.GT.NP) IDP=NP
      IF(ITYPE.GT.3) THEN
         IUT=ITYPE-3
         ITYPE=4
      END IF
      GO TO (09,19,29,39)ITYPE
C
C**  TYPE 1
C**  SET UP EQUATIONS FOR FRONT LINE TRACE
C
 09   PRINT *,'----------------------'
      PRINT *,'   FRONT LINE TRACE'
      PRINT *,'----------------------'
      WRITE(13,*)'----------------------'
      WRITE(13,*)'   FRONT LINE TRACE'
      WRITE(13,*)'----------------------'
C**  INCREMENT THE ROW BY 1
C
      NEQ=NEQ+1
C...........................................................
C**  FROM THE UNITS DELIVERED TO THE FRONT (M=1) AND THOSE
C**  UNITS DELIVERED BY INTRATHEATER AC (M=3)
C
C**  FOR EACH PERIOD UP TO THE DESIRED TIME
C
      DO 10 L=1,IDP
C
C**  FOR EACH UNIT WITH NFT(I).NE.0
C
         DO 11 I=1,NUNITS+1
            IF (NFT(I).EQ.0) GO TO 11
            DO 15 M=1,3
               IF(I.GT.IYP.AND.I.LE.NUNITS.AND.M.NE.2) GO TO 15
               IF(I.LE.IYP.AND.M.EQ.2) GO TO 15
                  IF(LMT(1).LT.1.AND.IAB(I).EQ.0.AND.M.EQ.1) GO TO 15
                  IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 15
                  IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 15
                  IF(IAB(I).EQ.1.AND.M.NE.1) GO TO 15
               AIJ(NEQ,LPU(I,M,L))=NFT(I)
               WRITE(13,03)NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1            UNAME(I),MD(M),L
               IF (LANS.EQ.0) GO TO 15
               PRINT 03,NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1            UNAME(I),MD(M),L
 15         CONTINUE
 11      CONTINUE
 10   CONTINUE
C
C**  FOR EACH UNIT GOING TO THE FRONT (1...IYP) WITHOUT
C**  AIRLIFT (M=2)
C
      DO 12 I=1,IYP
         IF(NFT(I).EQ.0.OR.NTV(I).EQ.0) GO TO 12
```

```
          IF(IAB(I).EQ.1) GO TO 12
            MY=INT((DIST(2))/REAL(NTV(I)*LP))
            IF (MY.GT.IDP) GO TO 12
C
C**   FOR EACH PERIOD UNTIL IDP-MY
C
          DO 13 L=1,IDP-MY
            AIJ(NEQ,LPU(I,2,L))=NFT(I)
            WRITE(13,03)NEQ,LPU(I,2,L),AIJ(NEQ,LPU(I,2,L)),
     1         UNAME(I),MD(2),L
            IF (LANS.EQ.0) GO TO 13
            PRINT 03,NEQ,LPU(I,2,L),AIJ(NEQ,LPU(I,2,L)),
     1         UNAME(I),MD(2),L
 13       CONTINUE
 12     CONTINUE
        RHS(NEQ)=OBJ
        WRITE(13,08)NEQ,RHS(NEQ)
        IF(LANS.EQ.1) PRINT 08,NEQ,RHS(NEQ)
C..........................................................
        RETURN
C
C**   TYPE 2
C**   SET UP EQUATIONS FOR ANTI TANK
C
 19     PRINT *,'-----------------------'
        PRINT *,'       ANTI TANK'
        PRINT *,'-----------------------'
        WRITE(13,*)'-----------------------'
        WRITE(13,*)'       ANTI TANK'
        WRITE(13,*)'-----------------------'
C
C**   INCREMENT THE ROW BY 1
C
        NEQ=NEQ+1
C.........................................................
C**   FROM THE FRONT
C**   FOR EACH PERIOD UP TO THE DESIRED TIME
C
        DO 20 L=1,IDP
C
C**   FOR EACH UNIT WITH NAT(I).NE.0
C
          DO 21 I=1,NUNITS+1
            IF(NAT(I).EQ.0) GO TO 21
            DO 25 M=1,3
              IF(I.GT.IYP.AND.I.LE.NUNITS.AND.M.NE.2) GO TO 25
              IF(I.LE.IYP.AND.M.EQ.2) GO TO 25
                IF(LMT(1).LT.1.AND.IAB(I).EQ.0.AND.M.EQ.1) GO TO 25
                IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 25
                IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 25
                IF(IAB(I).EQ.1.AND.M.NE.1) GO TO 25
              AIJ(NEQ,LPU(I,M,L))=NAT(I)
              WRITE(13,03)NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1          UNAME(I),MD(M),L
              IF (LANS.EQ.0) GO TO 25
```

```
                PRINT 03,NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1             UNAME(I),MD(M),L
 25           CONTINUE
 21        CONTINUE
 20     CONTINUE
C
C**   FROM THE APOD FOR EACH UNIT WALKING TO THE
C**   FRONT (J=1...IYP,M=2)
C
        DO 22 I=1,IYP
           IF(NAT(I).EQ.0.OR.NTV(I).EQ.0) GO TO 22
           MY=INT((DIST(2))/REAL(NTV(I)*LP))
           IF (MY.GT.IDP) GO TO 22
C
C**   FOR EACH PERIOD UNTIL IDP-MY
C
           DO 23 L=1,IDP-MY
              AIJ(NEQ,LPU(I,2,L))=NAT(I)
              WRITE(13,03)NEQ,LPU(I,2,L),AIJ(NEQ,LPU(I,2,L)),
     1           UNAME(I),MD(2),L
              IF (LANS.EQ.0) GO TO 23
              PRINT 03,NEQ,LPU(I,2,L),AIJ(NEQ,LPU(I,2,L)),
     1           UNAME(I),MD(2),L
 23        CONTINUE
 22     CONTINUE
        RHS(NEQ)=OBJ
        WRITE(13,08)NEQ,RHS(NEQ)
        IF(LANS.EQ.1) PRINT 08,NEQ,RHS(NEQ)
C...........................................................
        RETURN
C
C**   TYPE 3
C**   SET UP EQUATIONS FOR COMBAT POWER
C
 29     PRINT *,'-----------------------'
        PRINT *,'      FIREPOWER'
        PRINT *,'-----------------------'
        WRITE(13,*)'-----------------------'
        WRITE(13,*)'      FIREPOWER'
        WRITE(13,*)'-----------------------'
C**   INCREMENT THE ROW BY 1
        NEQ=NEQ+1
C..........................................................
C**   FROM THE FRONT
C**   FOR EACH PERIOD UP TO THE DESIRED TIME
C
        DO 30 L=1,IDP
C**   FOR EACH UNIT
           DO 31 I=1,NUNITS+1
              IF(NFP(I).EQ.0.OR.CPI(L).EQ.0) GO TO 31
              DO 35 M=1,3
                 IF(I.GT.IYP.AND.I.LE.NUNITS.AND.M.NE.2) GO TO 35
                 IF(I.LE.IYP.AND.M.EQ.2) GO TO 35
                    IF(LMT(1).LT.1.AND.IAB(I).EQ.0.AND.M.EQ.1) GO TO 35
                    IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 35
```

```
                  IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 35
                  IF(IAB(I).EQ.1.AND.M.NE.1) GO TO 35
               AIJ(NEQ,LPU(I,M,L))=NFP(I)*CPI(L)
               WRITE(13,03)NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1            UNAME(I),MD(M),L
               IF (LANS.EQ.0) GO TO 35
               PRINT 03,NEQ,LPU(I,M,L),AIJ(NEQ,LPU(I,M,L)),
     1            UNAME(I),MD(M),L
 35         CONTINUE
 31      CONTINUE
 30   CONTINUE
C
C**   FROM THE APOD FOR EACH UNIT WALKING TO THE FRONT (I=1...IYP,M=2)
C
      DO 32 I=1,IYP
         IF(NFP(I).EQ.0.OR.NTV(I).EQ.0) GO TO 32
         IF(IAB(I).EQ.1) GO TO 32
         MY=INT((DIST(2))/REAL(NTV(I)*LP))
         IF (MY.GT.IDP) GO TO 32
C
C**   FOR EACH PERIOD UNTIL IDP-MY
C
         DO 33 L=1,IDP-MY
            AIJ(NEQ,LPU(I,2,L))=NFP(I)*CPI(L)
            WRITE(13,03)NEQ,LPU(I,2,L),AIJ(NEQ,LPU(I,2,L)),
     1         UNAME(I),MD(2),L
            IF (LANS.EQ.0) GO TO 33
            PRINT 03,NEQ,LPU(I,2,L),AIJ(NEQ,LPU(I,2,L)),
     1         UNAME(I),MD(2),L
 33      CONTINUE
 32   CONTINUE
 34   RHS(NEQ)=OBJ
      WRITE(13,08)NEQ,RHS(NEQ)
      IF(LANS.EQ.1) PRINT 08,NEQ,RHS(NEQ)
C..............................................................
      RETURN
C
C**   TYPE 4
C**   GOAL FOR A SPECIFIC UNIT (IUT) DEPLOYED BY PERIOD IDP
C
 39   PRINT *,'-----------------------'
      PRINT *,'       UNIT GOAL'
      PRINT *,'-----------------------'
      WRITE(13,*)'-----------------------'
      WRITE(13,*)'       UNIT GOAL'
      WRITE(13,*)'-----------------------'
C**   INCREMENT THE ROW BY 1
      NEQ=NEQ+1
C..............................................................
C**   FROM THE FRONT
C**   FOR EACH PERIOD UP TO THE DESIRED TIME
C
      DO 40 L=1,IDP
         DO 41 M=1,3,2
                  IF(LMT(1).LT.1.AND.IAB(IUT).EQ.0.AND.M.EQ.1) GO TO 41
```

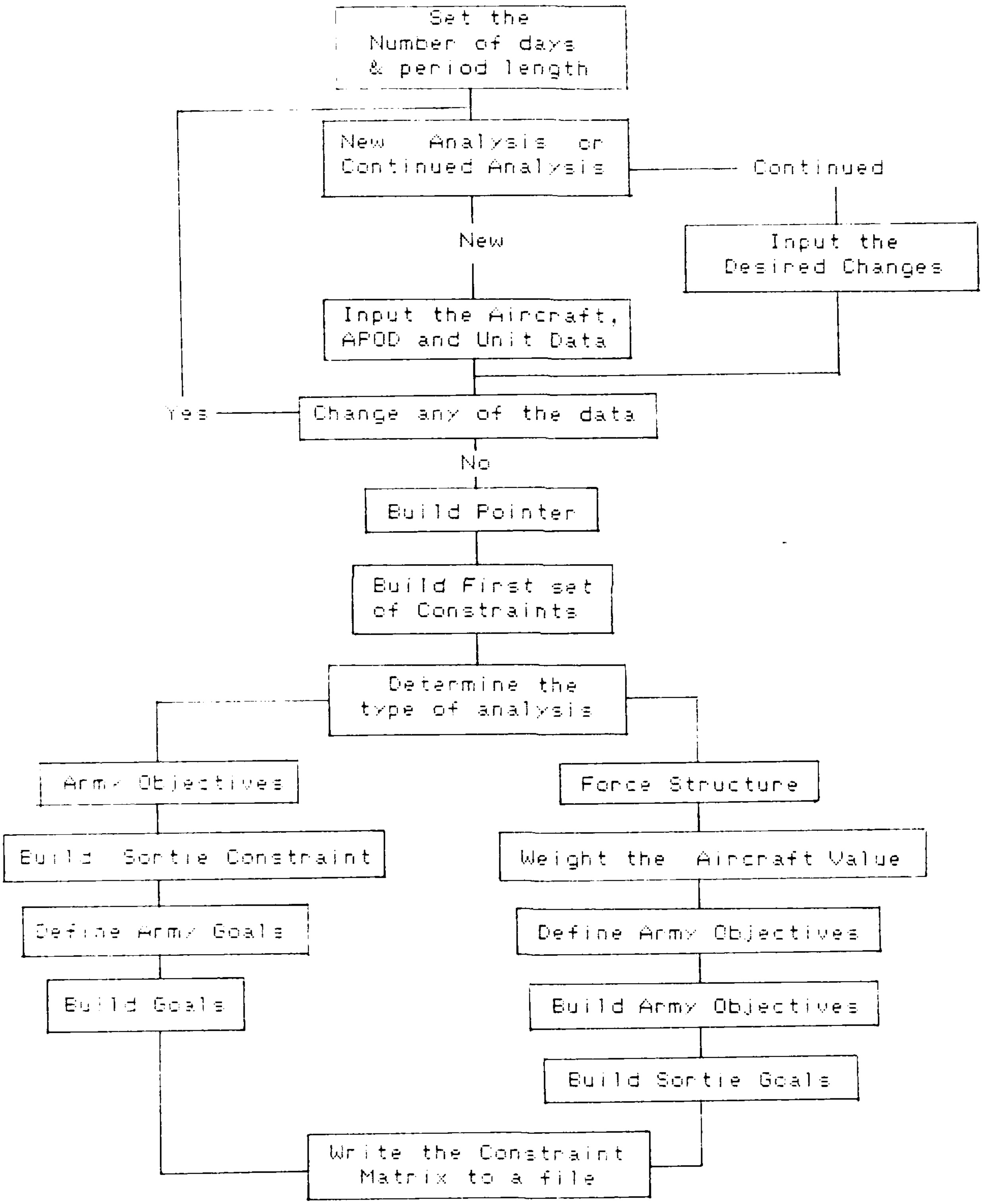
```
                IF(LMT(2).EQ.0.AND.M.EQ.1) GO TO 41
                IF(LMT(3).EQ.0.AND.M.EQ.1) GO TO 41
                IF(IAB(IUT).EQ.1.AND.M.NE.1) GO TO 41
            AIJ(NEQ,LPU(IUT,M,L))=1.0
            WRITE(13,03)NEQ,LPU(IUT,M,L),AIJ(NEQ,LPU(IUT,M,L)),
     1         UNAME(IUT),MD(M),L
            IF (LANS.EQ.0) GO TO 41
            PRINT 03,NEQ,LPU(IUT,M,L),AIJ(NEQ,LPU(IUT,M,L)),
     1         UNAME(IUT),MD(M),L
 41       CONTINUE
 40     CONTINUE
C
C**   FROM THE APOD FOR IUT
C
          IF (NTV(IUT).EQ.0) GO TO 42
          MY=INT((DIST(2))/REAL(NTV(IUT)*LP))
          IF (MY.GT.IDP) GO TO 42
C
C**   FOR EACH PERIOD UNTIL IDP-MY
C
          DO 43 L=1,IDP-MY
            AIJ(NEQ,LPU(IUT,2,L))=1.0
            WRITE(13,03)NEQ,LPU(IUT,2,L),AIJ(NEQ,LPU(IUT,2,L)),
     1         UNAME(IUT),MD(2),L
            IF (LANS.EQ.0) GO TO 43
            PRINT 03,NEQ,LPU(IUT,2,L),AIJ(NEQ,LPU(IUT,2,L)),
     1         UNAME(IUT),MD(2),L
 43       CONTINUE
 42     CONTINUE
 44     RHS(NEQ)=OBJ
        WRITE(13,08)NEQ,RHS(NEQ)
        IF(LANS.EQ.1) PRINT 08,NEQ,RHS(NEQ)
        LANS=0
C...........................................................
        RETURN
 03     FORMAT('AIJ(',2I4,')=',F14.5,3X,A14,2X,A5,I3)
 08     FORMAT ('RHS(',I4,')=',F14.5,/,'------------------------')
        END
C*****************************************************************
C** S8
        SUBROUTINE HEADER
C
C**   PRINTS OUT THE HEADER TO THE PROGRAM AS AN INTRODUCTION
C
        CHARACTER BLANK
        PRINT 12
        PRINT *,'    WELCOME TO'
        PRINT *
        PRINT *
        PRINT *,'    DDDDD      EEEEEE    PPPPPP     L          OOO
      C Y      Y'
        PRINT *,'    D    D     E         P     P    L         O   O
      C  Y    Y'
        PRINT *,'    D     D    E         P     P    L        O     O
      C   Y Y'
```

```
      PRINT *,'   D       D   EEEEE     PPPPPP      L       O       O
     C    Y'
      PRINT *,'   D       D   E         P           L       O       O
     C    Y'
      PRINT *,'   D      D    E         P           L        O     O
     C    Y'
      PRINT *,'   D     D     E         P           L         O   O
     C    Y'
      PRINT *,'   DDDDD       EEEEEE    P           LLLLLL     OOO
     C    Y'
      PRINT *
      PRINT *
      PRINT *,'                                     A'
      PRINT *
      PRINT *,'                          GOAL PROGRAMMING MODEL'
      PRINT *
      PRINT *,'                                 FOR THE'
      PRINT *
      PRINT *,'                    RAPID DEPLOYMENT OF ARMED FORCES'
      PRINT *
      PRINT *,'INPUT ANY CHARACTER TO CONTINUE.'
      READ *,BLANK
      PRINT 12
 12   FORMAT(//////////////////////////)
      RETURN
      END
C***********************************************************************
C S11
      SUBROUTINE FMAT
C
      COMMON/TAB/NP,LP,IP,NCR,NEQ,NPRIT,LL(10,2),LU(10,2),LPX(10,4,5,4),
     C   LPU(10,3,4),AIJ(150,300),RHS(150),LPS(3,5,4),LPSL(4),LPR(10),
     C   NT(150),LMT(3),NC(10),NWGT(150),NDV(150),NID
C
C**  SETS UP THE FILE FOR THE PAGP PROGRAM
C
      PRINT *,'FMAT'
      OPEN(15,FILE='IFILE')
      OPEN(14,FILE='TFILE')
      REWIND(15)
      REWIND(14)
C
C  WRITE THE IFILE AND FIND THE NUMBER OF TERMS (NT) FOR EACH ROW
C
      DO 10 I=1,NEQ
         DO 12 J=1,IP
            IF(AIJ(I,J).EQ.0) GO TO 12
            NT(I)=NT(I)+1
            WRITE(15,5)I,J,AIJ(I,J)
 5          FORMAT(2I4,F15.9)
 12      CONTINUE
         WRITE(15,5)I,0,RHS(I)
 10   CONTINUE
      CLOSE(15)
C
```

```
C**  WRITE THE INPUT PARAMETERS AND THE NUMBER OF TERMS PER ROW
C
      WRITE(14,*)NPRIT,IP,NCR,NEQ,NID
C
C**  THE NUMBER OF CONSTRAINTS FOR EACH PRIORITY
C
      DO 14 I=1,NPRIT
         WRITE(14,*)I,NC(I)
 14   CONTINUE
C
C**  THE TYPE OF DEVIATION VARIABLE TO MINIMIZE AND THE NUMBER OF
C**  TERMS IN THE EQUATION
C
      DO 16 I=1,NEQ
         WRITE(14,*)I,NDV(I),NWGT(I),NT(I)
 16   CONTINUE
      CLOSE(14)
C
      RETURN
      END
%
```

APPENDIX E

DEPLOY FLOWCHART



APPENDIX F

PAGP Subroutine and Function Listing

CINDX	--	Computes the relative cost coefficients for each variable in the current tableau and the objective function value at the current priority.
FIX	--	(function) Places floating point values that are within 1.E-5 of an integer to that integer.
PHSE1	--	Read in any real (equality) constraints and performs a simplex procedure to find an initial basic feasible solution.
PLACE	--	Puts the objective function weights for the deviation variables at the current priority in the correct position in the tableau.
POUT	--	Prepares and prints the solution information.
READ2	--	Reads in the goal constraints and objective function terms assigned to the current priority.
TEST	--	Determines the next entering variable's column and row.

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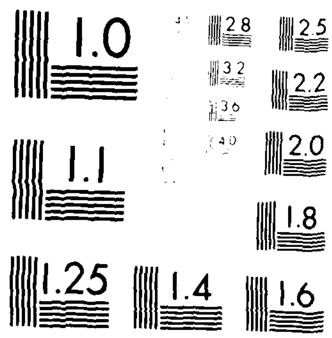
UNCLASSIFIED 06 DEC 84 AFIT/GOR/OS/84D-14 F/G 15/7 NL

END

FILMED

DTIC



MICROCOPY RESOLUTION TEST CHART

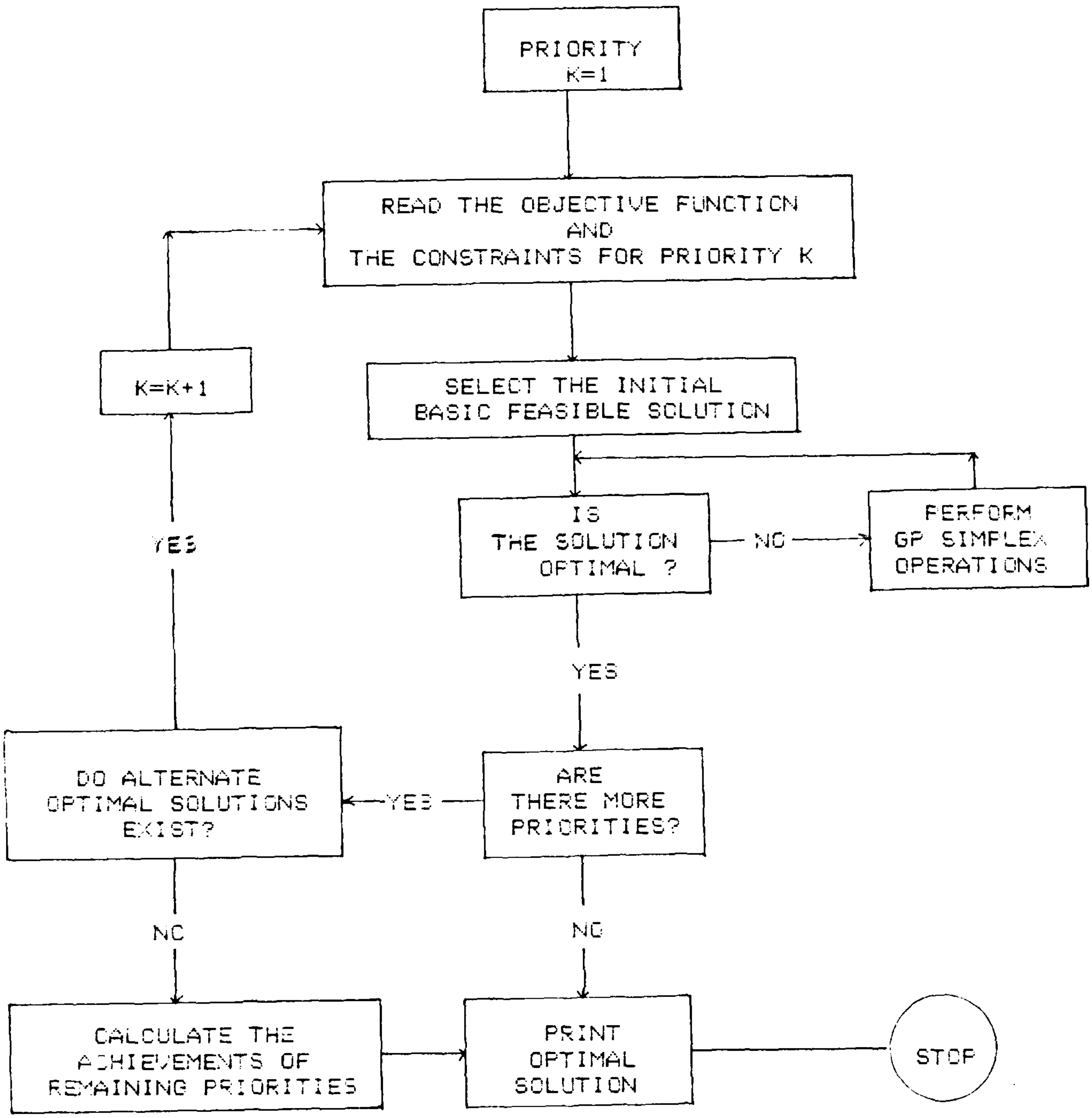
APPENDIX G

PAGE Variable Listing

Variable		Definition
IND(I)	--	Indicator row that marks the eligibility of a variable to enter the basis.
JCOL(I,1)	--	The type of variable in column I.
JCOL(I,2)	--	The subscript of the variable in column I.
JROW(I,1)	--	The type of basic variable in row I, where type is X=2; p=3; n=4.
JROW(I,2)	--	The subscript of the basic variable in row I.
NC(N)	--	The number of constraints assigned to priority N.
NCOLI	--	The number of columns in the current tableau.
NPRIC	--	The priority currently being optimized.
NPRIT	--	Total number of priorities in the problem.
NROWI	--	The number of rows in the current working tableau.
NVAR	--	The number of decision variables.
TA(N)	--	The total deviation from the goals at priority N.
TB(I)	--	The right hand side constant of the constraint in row I.
TE(I,J)	--	The coefficient of the variable in column J of the constraint in row I.
TL(N,J)	--	The weight assigned to the basic variable in row I at priority N.
TT(N,J)	--	The weight of the variable in column J at priority N.

APPENDIX H

Flowchart for PAGE Allocation Algorithm



APPENDIX I

PAGP Listing

```
      PROGRAM PAGP
C--------+---------+---------+---------+--------+---------+---------+--
C-  CAPT D. O. TATE  THESIS WORK
C--------+---------+---------+---------+--------+---------+---------+--
      CHARACTER KID(188)*24
      COMMON TT(10,402),TB(130),TE(130,402),TL(130,10),TA(10),INB(130),
     C   TI(10,402),JCOL(402,2),NCOLI,NROWI,NPRIC,NC(10),JROW(130,2),
     C   NVAR,NPRIT,IND(402),NTR(130),NDV(130),NID,NWGT(130),LCTR
      COMMON /PHASE1/ W,NRCON,NDVR
      COMMON /CHNG/NCON(130,10),NTOF(10)
      COMMON/CHAR/KID
      INTEGER ALTST
C
C **** READ IN PROBLEM DATA
C
      OPEN(13,FILE='IFILE')
      REWIND(13)
      OPEN(14,FILE='TFILE')
      REWIND(14)
      OPEN(15,FILE='RSFILE')
      REWIND(15)
C
C- INPUT THE #PRIORITIES, #VARIABLES, #REAL
C- CONSTRAINTS, AND NEQ
C
      READ(14,*)NPRIT,NVAR,NRCON,NEQ,NID
      OPEN(16,FILE='IDFILE')
      REWIND(16)
      DO 23 I=1,NID
         READ(16,6)K,KID(I)
 23   CONTINUE
 6    FORMAT(I4,3X,A24)
C
C- INPUT THE NUMBER OF CONSTRAINTS THAT WILL
C- BE ADDED AT EACH PRIORITY
C
      DO 22 NP=1,NPRIT
         READ(14,*)I,NC(NP)
         IF(I.NE.NP) THEN
            PRINT *,'I <> NP- I=',I,' NP=',NP
            STOP
         END IF
 22   CONTINUE
C
C-  READ IN THE DEVIATION VAR WEIGHTS AND THE NUMBER OF TERMS/EQUATION
C
      DO 20 NR=1,NEQ
         READ(14,*)I,NDV(I),NWGT(I),NTR(I)
         IF(I.NE.NR) THEN
            PRINT *,'I <> NR- I=',I,' NR=',NR
```

```
            STOP
          END IF
 20    CONTINUE
       PRINT 16,NPRIT,NVAR,NRCON,NEQ
       WRITE(15,16)NPRIT,NVAR,NRCON,NEQ
 16    FORMAT('NPRIT=',I4,' NVAR=',I4,' NRCON=',I4,' NEQ=',I4)
       DO 10 NP=1,NPRIT
 10    CONTINUE
 17    FORMAT('NC(',I4,')=',I4)
       I=0
C
C- INPUT THE SUBSCRIPTS OF THE CONSTRAINTS
C- TO BE ADDED AT A SPECIFIC PRIORITY
C
       DO 101 NP=1,NPRIT
          IF (NC(NP).EQ.0) GO TO 101
          NCTMP=NC(NP)
          DO 12 N=1,NCTMP
             I=I+1
             NCON(N,NP)=I
 12       CONTINUE
  101 CONTINUE
 13       FORMAT('NCON(',2I3,')=',I3)
C
C- INPUT THE NUMBER OF TERMS IN THE OBJECTIVE
C- FUNCTION AT EACH PRIORITY
C
       NTOF(1)=NC(1)
       DO 14 J=2,NPRIT
          NTOF(J)=NC(J)
 14    CONTINUE
 19    FORMAT('NTOF(',I3,')=',I3)
C
C **** INITIALIZE SUBPROBLEM DIMENSIONS AND COLUMN INDICATORS.
C
       LCTR=0
       NCOLI=0
       NROWI=0
       NPRIC=0
       DO 104 NCR=1,402
          IND(NCR)=1
          DO 102 NR=1,130
  102     TE(NR,NCR)=0.
          DO 103 NP=1,5
             TI(NP,NCR)=0.
  103     TT(NP,NCR)=0.
  104 CONTINUE
       DO 105 NR=1,130
          INB(NR)=0
       DO 105 NP=1,10
  105 TL(NR,NP)=0.
C
C **** CHECK FOR REAL CONSTRAINTS.
C
       IF (NRCON.EQ.0) GO TO 106
```

```
      CALL PHSE1
      IF (NDVR.LE.0) GO TO 116
      IF (W.GT.0.) GO TO 117
C
C **** THE PARTITIONING ALGORITHM BEGINS.
C
  106 NPRIC=NPRIC+1
      IF (NPRIC.EQ.1.AND.NRCON.EQ.0) GO TO 107
      GO TO 108
  107 PRINT *,'MUST INCLUDE SUBROUTINE READ1'
      GO TO 109
  108 CALL READ2
      NPIV=0
  109 CALL CINDX
      CALL TEST (NEVC,NDVR)
C
C **** IF NEVC IS LESS THAN ZERO, THE SUBPROBLEM IS OPTIMIZED.
C
      IF (NEVC.LE.0) THEN
         PRINT *,'SUBPROBLEM OPTIMIZED'
      WRITE(15,*)'SUBPROBLEM OPTIMIZED'
         GO TO 110
         END IF
C
C **** IF NDVR IS LESS THAN ZERO, NO MINIMUM POSITIVE RATIO WAS FOUND.
C
      IF (NDVR.LE.0) THEN
         PRINT *,'NO MINIMUM POSITIVE RATIO FOUND'
         WRITE(15,*)'NO MINIMUM POSITIVE RATIO FOUND'
         GO TO 116
         END IF
      CALL PERM (NEVC,NDVR)
      NPIV=NPIV+1
      PRINT *,'PIVOT# ',NPIV,'  NPRIC=',NPRIC
      WRITE(15,*)'PIVOT# ',NPIV,'  NPRIC=',NPRIC
      GO TO 109
C
C **** IF THERE ARE NO MORE PRIORITIES, TOTAL PROBLEM IS OPTIMIZED.
C **** PRINT THE OPTIMAL SOLUTION.
C
  110 IF (NPRIC.EQ.NPRIT) GO TO 115
C
C **** SINCE THERE ARE MORE PRIORITIES, MOVE ON TO THE NEXT SUBPROBLEM
C **** IF THERE ARE ALTERNATE SOLUTIONS.  FIRST, ELIMINATE THOSE
C **** COLUMNS WHICH CAN NOT ENTER THE BASIS.  IF THERE ARE NO
C **** ALTERNATE SOLUTIONS, PRINT THE UNIQUE OPTIMAL SOLUTION.
C
      ALTST=0
      DO 112 NCR=1,NCOLI
         IF (IND(NCR).EQ.0) GO TO 112
         IF (TI(NPRIC,NCR).GT.0.) GO TO 112
         DO 111 NR=1,NROWI
            IF (JROW(NR,1).EQ.JCOL(NCR,1).AND.JROW(NR,2).EQ.JCOL(NCR,2))
     1         GO TO 112
  111    CONTINUE
```

```
         ALTST=1
  112 CONTINUE
C
C **** IF ALTST=1, THERE ARE ALTERNATE SOLUTIONS.
C
      IF (ALTST.EQ.1) THEN
         PRINT *,'THERE ARE ALTERNATE SOLUTIONS'
         WRITE(15,*)'THERE ARE ALTERNATE SOLUTIONS'
         GO TO 113
         END IF
      GO TO 115
C
C **** ELIMINATE THOSE COLUMNS WITH A POSITIVE RELATIVE COST AT
C **** PRIORITY NPRIC.
C
  113 DO 114 NCR=1,NCOLI
  114 IF (TI(NPRIC,NCR).GT.0.) IND(NCR)=0
      GO TO 106
C
C **** THE OPTIMIZATION IS OVER. PRINT OUT THE FINAL SOLUTION.
C
  115 CALL POUT
      GO TO 119
  116 WRITE (6,123) NPRIC
      GO TO 119
  117 WRITE (6,124) W
      WRITE (6,125)
      DO 118 NR=1,NROWI
         WRITE (6,126) JROW(NR,1),JROW(NR,2),TB(NR)
  118 CONTINUE
  119 WRITE(6,*)'OPTIMIZATION IS FINISHED.  ANSWER IS IN FILE GPANS.'
      STOP
C
  120 FORMAT (3I5)
  121 FORMAT (10I5)
  122 FORMAT (16I5)
  123 FORMAT (/  40H   THE PROGRAM TERMINATED ON SUBPROBLEM ,I4, 42H  NO
     1 MINIMUM POSITIVE RATIO COULD BE FOUND)
  124 FORMAT (/  65H  THE PROGRAM TERMINATED IN PHASE 1 WITH OBJECTIVE F
     1UNCTION VALUE,F15.4)
  125 FORMAT (/  55H  THE OPTIMAL SOLUTION TO THE PHASE 1 PROBLEM IS
     1    //    6H  TYPE,2X,  3HSUB,8X,  5HVALUE)
  126 FORMAT (2I5,F15.4)
C
      END
      SUBROUTINE PHSE1
C
C **** SUBROUTINE PHSE1 READS IN ANY REAL CONSTRAINTS AND PERFORMS A
C **** PHASE 1 SIMPLEX PROCEDURE IN ORDER TO FIND AN INITIAL BASIC
C **** FEASIBLE SOLUTION.
C
      COMMON TT(10,402),TB(130),TE(130,402),TL(130,10),TA(10),INB(130),
     C   TI(10,402),JCOL(402,2),NCOLI,NROWI,NPRIC,NC(10),JROW(130,2),
     C   NVAR,NPRIT,IND(402),NTR(130),NDV(130),NID,NWGT(130),LCTR
      COMMON /PHASE1/ W,NRCON,NDVR
```

```
      DIMENSION C(402), CR(402), CB(130)
      NPIV=0
C
C **** SET COLUMN AND ROW HEADINGS
C
      DO 101 NV=1,NVAR
         JCOL(NV,1)=2
  101 JCOL(NV,2)=NV
      DO 102 NR=1,NRCON
         JROW(NR,1)=1
         JROW(NR,2)=NR
         NAR=NVAR+NR
         JCOL(NAR,1)=1
  102 JCOL(NAR,2)=NR
C
C **** READ IN COEFFICIENTS AND RHS OF REAL CONSTRAINTS
C
      DO 103 NR=1,NRCON
C-
C- INPUT THE RHS OF REAL CONSTRAINT NUMBER ,NR
C- INPUT THE COEFFICIENTS OF REAL CONSTRAINT NUMBER
C-
         DO 30 NV=1,NTR(NR)
            READ(13,6)I,J,TE(I,J)
 31         FORMAT('TE(I,J)=',I3,3X,I3,3X,F9.2)
            IF(I.NE.NR) THEN
               PRINT *,'** I  <>  NR ** I=',I,' NR=',NR,' J=',J
               STOP
            END IF
 30      CONTINUE
         READ(13,6)I,J,TB(I)
 6       FORMAT(2I4,F15.9)
 32      FORMAT('TB(I)=',I3,3X,F9.2)
  103 CONTINUE
      WRITE(15,*)'PHSE1 DATA ENTERED'
C
C **** PUT IDENTITY MATRIX IN FOR ARTIFICIAL VARIABLES
C
      DO 104 NR=1,NRCON
         NAR=NVAR+NR
         INB(NR)=NAR
  104 TE(NR,NAR)=1.
      WRITE(15,*)
      WRITE(15,*)'THE STARTING BASIS.'
      PRINT *,'THE STARTING BASIS.'
      DO 55 I=1,NRCON
         WRITE(15,56)I,INB(I)
 55      PRINT 56,I,INB(I)
 56   FORMAT('INB:',I3,3X,I4)
C
C **** SET C(J)=0 FOR ALL DECISION VARIABLES AND C(J)=1 FOR ALL
C **** ARTIFICIAL VARIABLES
C
      DO 105 NV=1,NVAR
  105 C(NV)=0.
```

```
      DO 106 NR=1,NRCON
         CB(NR)=1.
         NAR=NVAR+NR
  106 C(NAR)=1.
C
C*** CALCULATE RELATIVE COST COEFFICIENTS CR(.)
C
      NCOL=NVAR+NRCON
  107 DO 108 NV=1,NCOL
         CR(NV)=C(NV)
      DO 108 NR=1,NRCON
  108 CR(NV)=CR(NV)-CB(NR)*TE(NR,NV)
C
C **** CHECK FOR OPTIMALITY
C
      VEVC=0.
      NEVC=0
      DO 109 NCO=1,NCOL
         NV=NCO
         IF (CR(NV).GE.0.) GO TO 109
         IF (CR(NV).GE.VEVC) GO TO 109
         VEVC=CR(NV)
         NEVC=NV
  109 CONTINUE
C
C **** IF NEVC=0, PHASE 1 IS OPTIMIZED.  CALCULATE OBJECTIVE FUNCTION.
C
      IF (NEVC.EQ.0) GO TO 115
C
C **** DETERMINE DEPARTING VARIABLES ROW.
C
      NDVR=0
      VDVR=10.0E+20
      DO 111 NRI=1,NRCON
         NR=NRI
         IF (TE(NR,NEVC).LE.0.) GO TO 111
         V=TB(NR)/TE(NR,NEVC)
         IF (NDVR.EQ.0) GO TO 110
         IF (V-VDVR) 110,110,111
  110    VDVR=V
         NDVR=NR
  111 CONTINUE
C
C **** IF NDVR=0, MINIMUM RATIO RULE FAILED.  RETURN.
C
      IF (NDVR.EQ.0) RETURN
C
C **** PERFORM THE PIVOT.  REPLACE HEADINGS AND COST COEFFICIENT.
C
      JROW(NDVR,1)=JCOL(NEVC,1)
      JROW(NDVR,2)=JCOL(NEVC,2)
      CB(NDVR)=C(NEVC)
      NDVC=INB(NDVR)
      INB(NDVR)=NEVC
         PRINT 5,NDVR,NDVC,VDVR,NEVC,VEVC
```

```
      WRITE(15,5)NDVR,NDVC,VDVR,NEVC,VEVC
 5    FORMAT(5X,'NDVR=',I4,3X,'NDVC=',I4,3X,'VDVR=',F10.3,
     1   /17X,'NEVC=',I4,3X,'VEVC=',F10.3)
C
C **** COMPUTE NEW TE ARRAY
C
      PIV=TE(NDVR,NEVC)
      PIB=TB(NDVR)
      DO 113 NR=1,NRCON
         IF (NR.EQ.NDVR) GO TO 113
         IF (ABS(TE(NR,NEVC)).LE.0.0005) GO TO 113
         PIX=TE(NR,NEVC)/PIV
         TB(NR)=FIX(TB(NR)-PIX*PIB)
         DO 112 NV=1,NCOL
  112    TE(NR,NV)=FIX(TE(NR,NV)-TE(NDVR,NV)*PIX)
  113 CONTINUE
      TB(NDVR)=FIX(PIB/PIV)
      DO 114 NV=1,NCOL
  114 TE(NDVR,NV)=FIX(TE(NDVR,NV)/PIV)
C
C **** END OF PIVOT OPERATIONS.  PROCEED TO NEXT ITERATION.
C
      NPIV=NPIV+1
      PRINT *,'PIVOT # ',NPIV,'  NPRIC=',NPRIC
      WRITE(15,*)'PIVOT # ',NPIV,'  NPRIC=',NPRIC
      GO TO 107
C
C **** CALCULATE W, THE PHASE-1 OBJECTIVE FUNCTION.
C
  115 W=0.
      DO 116 NR=1,NRCON
  116 W=W+TB(NR)*CB(NR)
C
C **** INITIALIZE THOSE PORTIONS OF THE TABLEAU ASSIGNED TO THE
C **** ARTIFICIAL VARIABLES.
C
      DO 117 NR=1,NRCON
      DO 117 NV=1,NCOL
         IF (NV.LE.NVAR) GO TO 117
         TE(NR,NV)=0.
  117 CONTINUE
C
C **** UPDATE NCOLI AND NROWI PARAMETERS.
C
      NROWI=NRCON
      NCOLI=NVAR
      PRINT *,'TOTAL PIVOTS=',NPIV
      WRITE(15,*)'TOTAL PIVOT=',NPIV
      RETURN
C
C
      END
      SUBROUTINE READ2
C
C **** SUBROUTINE READ2 READS IN THE GOAL CONSTRAINTS AND OBJECTIVE
```

```
C **** FUNCTION TERMS ASSIGNED TO PRIORITY NPRIC.
C **** SUBROUTINE READ2 IS ALSO USED TO READ IN THE FIRST PRIORITY GOAL
C **** CONSTRAINTS AND OBJECTIVE FUNCTION TERMS IF REAL CONSTRAINTS ARE
C **** PRESENT.
C
      COMMON TT(10,402),TB(130),TE(130,402),TL(130,10),TA(10),INB(130),
     C   TI(10,402),JCOL(402,2),NCOLI,NROWI,NPRIC,NC(10),JROW(130,2),
     C   NVAR,NPRIT,IND(402),NTR(130),NDV(130),NID,NWGT(130),LCTR
      COMMON /CHNG/NCON(130,10),NTOF(10)
         IF(NC(NPRIC).EQ.0) GO TO 107
C
C **** READ IN THE COEFFICIENTS OF THE X'S.
C
      NCTMP=NC(NPRIC)
      DO 106 NRI=1,NCTMP
         NR=NRI+NROWI
         NC1=NCOLI+2*NRI-1
         NC2=NCOLI+2*NRI
         JCOL(NC1,1)=4
         JCOL(NC1,2)=NCON(NRI,NPRIC)
         JCOL(NC2,1)=3
         JCOL(NC2,2)=NCON(NRI,NPRIC)
C
C- INPUT THE COEFFICIENTS OF THE DECISION VARIABLES
C- AND RHS FOR PRIORITY #NPRIC AND CONSTRAINT #NRI
C
         DO 30 NV=1,NTR(NR)
            READ(13,6)I,J,TE(I,J)
 31         FORMAT('TE(I,J)=',I3,3X,I3,3X,F9.2)
            IF(I.NE.NR) THEN
               PRINT *,'** I  <>  NR ** I=',I,' NR=',NR,' J=',J
               STOP
            END IF
 30      CONTINUE
         READ(13,6)I,J,TB(I)
 6       FORMAT(2I4,F15.9)
 32      FORMAT('TB(I)=',I3,3X,F9.2)
         TE(NR,NC1)=1.
         INB(NR)=NC1
         TE(NR,NC2)=-1.
C
C **** PERFORM THE ROW REDUCTION.
C
         DO 102 NRC=1,NROWI
            IF (JROW(NRC,1).NE.2) GO TO 102
            J=JROW(NRC,2)
            TB(NR)=TB(NR)-TE(NR,J)*TB(NRC)
            DO 101 NCR=1,NC2
               IF (NCR.EQ.J) GO TO 101
               TE(NR,NCR)=TE(NR,NCR)-TE(NR,J)*TE(NRC,NCR)
  101       CONTINUE
            TE(NR,J)=0.
  102    CONTINUE
C
C **** DETERMINE THE DEVIATIONAL VARIABLE TO ENTER THE BASIS.
```

```
C
        IF (TB(NR)) 103,105,105
C
C **** SINCE TB IS LESS THAN ZERO, MULTIPLY THE ROW BY -1 AND ENTER D+
C **** IN THE BASIS.
C
  103   DO 104 NCR=1,NC2
  104   TE(NR,NCR)=-TE(NR,NCR)
        TB(NR)=-TB(NR)
        JROW(NR,1)=3
        JROW(NR,2)=NCON(NRI,NPRIC)
        GO TO 106
C
C **** SINCE TB IS GREATER THAN OR EQUAL TO ZERO ENTER D- IN THE BASIS.
C
  105   JROW(NR,1)=4
        JROW(NR,2)=NCON(NRI,NPRIC)
  106 CONTINUE
C
C **** INCREASE THE PARAMETERS NCOLI AND NROWI.
C
      NX=NROWI
      NCOLI=NC2
      NROWI=NR
C
C- AT  PRIORITY #NPRIC, INPUT THE SUBSCRIPT, TYPE, AND
C- WEIGHT OF EACH TERM IN THE OBJECTIVE FUNCTION.
C    (IF TERM IS POSITIVE DEVIATIONAL, TYPE=3)
C    (IF TERM IS NEGATIVE DEVIATIONAL, TYPE=4)
C
  107 NTTMP=NTOF(NPRIC)
      DO 108 NT=1,NTTMP
         LCTR=LCTR+1
         ISUB=LCTR
         ITYPE=NDV(NX+NT)
         WGHT=NWGT(NX+NT)
         CALL PLACE (ISUB.ITYPE,WGHT)
  108 CONTINUE
      RETURN
C
C
      END
      SUBROUTINE PLACE (ISUB,ITYPE,WGHT)
C
C **** SUBROUTINE PLACE PUTS THE OBJECTIVE FUNCTION WEIGHTS FOR THE
C **** DEVIATION VARIABLES AT THE CURRENT PRIORITY LEVEL (NPRIC) IN THE
C **** CORRECT POSITIONS IN THE AUGMENTED TABLEAU.
C ****
C **** ISUB=THE SUBSCRIPT OF THE DEVIATIONAL VARIABLE
C ****
C **** ITYPE=3, IF POSITIVE DEVIATIONAL VARIABLE (D+)
C ****       4, IF NEGATIVE DEVIATIONAL VARIABLE (D-)
C ****
C **** WGHT=THE CARDINAL WEIGHT OF THIS DEVIATIONAL VARIABLE AT THE
C ****      CURRENT PRIORITY LEVEL
```

```
C
      COMMON TT(10,402),TB(130),TE(130,402),TL(130,10),TA(10),INB(130),
     C   TI(10,402),JCOL(402,2),NCOLI,NROWI,NPRIC,NC(10),JROW(130,2),
     C   NVAR,NPRIT,IND(402),NTR(130),NDV(130),NID,NWGT(130),LCTR
      COMMON /CHNG/NCON(130,10),NTOF(10)
C
C **** PLACE THE WEIGHT IN THE PROPER COLUMN IN THE TOP STUB.
C
      NC1=NVAR+1
      DO 101 NCR=NC1,NCOLI
         IF (JCOL(NCR,1).EQ.ITYPE.AND.JCOL(NCR,2).EQ.ISUB) GO TO 102
  101 CONTINUE
  102 TT(NPRIC,NCR)=WGHT
C
C **** PLACE THE WEIGHT IN THE PROPER ROW IN THE LEFT STUB.
C
      DO 103 NR=1,NROWI
         IF (JROW(NR,1).EQ.ITYPE.AND.JROW(NR,2).EQ.ISUB) GO TO 104
  103 CONTINUE
      GO TO 105
  104 TL(NR,NPRIC)=WGHT
  105 CONTINUE
      RETURN
C
      END
      SUBROUTINE CINDX
C
C **** SUBROUTINE CINDX COMPUTES THE RELATIVE COST COEFFICIENTS FOR EACH
C **** VARIABLE IN THE CURRENT TABLEAU(THE TI( . , . ) ARRAY) AND THE
C **** OBJECTIVE FUNCTION VALUE(THE TA(.) ARRAY) AT THE CURRENT
C **** PRIORITY(NPRIC)
C
      COMMON TT(10,402),TB(130),TE(130,402),TL(130,10),TA(10),INB(130),
     C   TI(10,402),JCOL(402,2),NCOLI,NROWI,NPRIC,NC(10),JROW(130,2),
     C   NVAR,NPRIT,IND(402),NTR(130),NDV(130),NID,NWGT(130),LCTR
C
C **** COMPUTE TA(NPRIC) AND TI(NPRIC,NC)   NC=1,....,NCOLI
C
      TA(NPRIC)=0.
      DO 101 NR=1,NROWI
  101 TA(NPRIC)=TA(NPRIC)+TB(NR)*TL(NR,NPRIC)
      DO 102 NCR=1,NCOLI
         TI(NPRIC,NCR)=TT(NPRIC,NCR)
      DO 102 NR=1,NROWI
  102 TI(NPRIC,NCR)=TI(NPRIC,NCR)-TE(NR,NCR)*TL(NR,NPRIC)
      RETURN
C
      END
      SUBROUTINE TEST (NEVC,NDVR)
C
C **** SUBROUTINE TEST DETERMINES THE NEXT ENTERING VARIABLE'S COLUMN
C **** (NEVC) AND THE NEXT DEPARTING VARIABLE'S ROW(NDVR).  IF NO
C **** FURTHER OPTIMIZATION IS POSSIBLE, THE VALUE NEVC=0 IS RETURNED.
C **** IF NDVR=0 IS RETURNED, NO MINIMUM POSITIVE RATIO COULD BE FOUND
C **** IN THE CURRENT PIVOT OPERATION,I.E., ALL OF THE COEFFICIENTS
```

```
C **** TE( . ,NEVC) ARE NONPOSITIVE.
C
      CHARACTER KID(188)*24
      COMMON TT(10,402),TB(130),TE(130,402),TL(130,10),TA(10),INB(130),
     C   TI(10,402),JCOL(402,2),NCOLI,NROWI,NPRIC,NC(10),JROW(130,2),
     C   NVAR,NPRIT,IND(402),NTR(130),NDV(130),NID,NWGT(130),LCTR
      COMMON/CHAR/KID
      NDVR=0
      NEVC=0
      VEVC=0.
      VDVR=10.0E+20
C
C **** DETERMINE ENTERING VARIABLE'S COLUMN.
C
      DO 101 NCR=1,NCOLI
         IF (TI(NPRIC,NCR).GE.0.) GO TO 101
         IF (IND(NCR).EQ.0) GO TO 101
         IF (TI(NPRIC,NCR).GE.VEVC) GO TO 101
         NEVC=NCR
         VEVC=TI(NPRIC,NCR)
  101 CONTINUE
C
C **** IF NEVC=0, SUBPROBLEM NPRIC IS OPTIMIZED. RETURN.
C
      IF (NEVC.EQ.0) GO TO 107
C
C **** DETERMINE DEPARTING VARIABLE'S ROW.
C
      DO 105 NR=1,NROWI
         IF (TE(NR,NEVC).LE.0.) GO TO 105
         V=TB(NR)/TE(NR,NEVC)
         IF (NDVR.EQ.0) GO TO 104
         IF (V-VDVR) 104,102,105
  102    DO 103 NP=1,NPRIC
            IF (TL(NR,NP)-TL(NDVR,NP)) 105,103,104
  103    CONTINUE
  104    VDVR=V
         NDVR=NR
  105 CONTINUE
  107 IF(NDVR.EQ.0) RETURN
      NDVC=INB(NDVR)
      INB(NDVR)=NEVC
      PRINT 5,NDVR,NDVC,VDVR,NEVC,VEVC
      WRITE(15,5)NDVR,NDVC,VDVR,NEVC,VEVC
      RETURN
 5    FORMAT(5X,'NDVR=',I4,3X,'NDVC=',I4,3X,'VDVR=',F10.3,
     1   /17X,'NEVC=',I4,3X,'VEVC=',F10.3)
C
      END
      SUBROUTINE PERM (NEVC,NDVR)
C
C **** SUBROUTINE PERM PERFORMS THE PIVOT OPERATION USING THE PIVOT
C **** ELEMENT IN COLUMN NEVC AND ROW NDVR AND COMPUTES THE NEW TABLEAU.
C
      COMMON TT(10,402),TB(130),TE(130,402),TL(130,10),TA(10),INB(130),
```

```
     C   TI(10,402),JCOL(402,2),NCOLI,NROWI,NPRIC,NC(10),JROW(130,2),
     C   NVAR,NPRIT,IND(402),NTR(130),NDV(130),NID,NWGT(130),LCTR
C
C **** REPLACE HEADING FOR ROW NDVR.
C
      JROW(NDVR,1)=JCOL(NEVC,1)
      JROW(NDVR,2)=JCOL(NEVC,2)
C
C **** REPLACE TL VECTOR FOR ROW NDVR
C
      DO 101 NP=1,NPRIC
  101 TL(NDVR,NP)=TT(NP,NEVC)
C
C **** COMPUTE NEW TE ARRAY.
C
      PIV=TE(NDVR,NEVC)
      PIB=TB(NDVR)
      DO 103 NR=1,NROWI
         IF (NR.EQ.NDVR) GO TO 103
         IF (ABS(TE(NR,NEVC)).LE.0.0005) GO TO 103
         PIX=TE(NR,NEVC)/PIV
         TB(NR)=FIX(TB(NR)-PIX*PIB)
         DO 102 NCR=1,NCOLI
  102    TE(NR,NCR)=FIX(TE(NR,NCR)-TE(NDVR,NCR)*PIX)
  103 CONTINUE
      TB(NDVR)=FIX(PIB/PIV)
      DO 104 NCR=1,NCOLI
  104 TE(NDVR,NCR)=FIX(TE(NDVR,NCR)/PIV)
      RETURN
C
      END
      FUNCTION FIX(Z)
C
C **** FUNCTION FIX BRINGS FLOATING POINT VALUES THAT ARE WITHIN 1.E-3
C **** OF AN INTEGER TO THAT INTEGER.
C
      FIX=AINT(Z+SIGN(.5,Z))
      IF (ABS(FIX-Z).GT. 1.E-3) FIX=Z
C
      RETURN
C
      END
      SUBROUTINE POUT
C
C **** SUBROUTINE POUT PREPARES AND PRINTS THE SOLUTION INFORMATION.
C
      CHARACTER KID(188)*24
      COMMON TT(10,402),TB(130),TE(130,402),TL(130,10),TA(10),INB(130),
     C   TI(10,402),JCOL(402,2),NCOLI,NROWI,NPRIC,NC(10),JROW(130,2),
     C   NVAR,NPRIT,IND(402),NTR(130),NDV(130),NID,NWGT(130),LCTR
      COMMON /CHNG/NCON(130,10),NTOF(10)
      COMMON/CHAR/KID
      DIMENSION WOUT(402,4), RLHS(130,10)
      DIMENSION DIFF(130)
      OPEN (11,FILE='GPANS')
```

```
      REWIND 11
      WRITE (11,122)
      WRITE (11,123) NPRIC,NROWI
C
C **** OUTPUT ARRAY IS ZEROED.
C
      DO 101 I=1,402
      DO 101 J=1,4
  101 WOUT(I,J)=0.
C
C **** OUTPUT ARRAY IS FILLED.
C
      DO 102 NP=1,NPRIC
  102 WOUT(NP,1)=FIX(TA(NP))
      DO 103 NR=1,NROWI
         I1=JROW(NR,1)
         I2=JROW(NR,2)
  103 WOUT(I2,I1)=FIX(TB(NR))
C
C **** IF ALL PRIORITIES HAVE BEEN INCLUDED, PRINT OPTIMAL SOLUTION.
C **** IF NOT, WE MUST CALCULATE VALUES FOR REMAINING TA'S AND D- AND D+
C
      IF (NPRIC.GE.NPRIT) GO TO 114
      NP1=NPRIC+1
      DO 113 NP=NP1,NPRIT
         TA(NP)=0.
         IF (NC(NP).EQ.0) GO TO 106
C
C **** READ IN THE GOAL CONSTRAINTS ASSIGNED TO PRIORITY NP.
C
         NCTMP=NC(NP)
         DO 105 NCI=1,NCTMP
            NR=NROWI+NCI
C
C- INPUT THE COEFFICIENTS OF THE DECISION VARIABLES
C- AND RHS FOR PRIORITY #NPRIC AND CONSTRAINT #NRI
C
        DO 30 NV=1,NTR(NR)
            READ(13,6)I,J,TE(I,J)
           IF(I.NE.NR) THEN
                PRINT *,'** I  <>  NR ** I=',I,' NR=',NR,' J=',J
                STOP
            END IF
 30      CONTINUE
         READ(13,6)I,J,TB(I)
 6       FORMAT(2I4,F15.9)
            RLHS(NCI,NP)=0.
            DO 104 NV=1,NVAR
  104       RLHS(NCI,NP)=RLHS(NCI,NP)+TE(NR,NV)*WOUT(NV,2)
            DIFF(NCI)=TB(NR)-RLHS(NCI,NP)
  105    CONTINUE
C
C
C- AT  PRIORITY #NPRIC, INPUT THE SUBSCRIPT, TYPE, AND
C- WEIGHT OF EACH TERM IN THE OBJECTIVE FUNCTION.
```

```
C     (IF TERM IS POSITIVE DEVIATIONAL, TYPE=3)
C     (IF TERM IS NEGATIVE DEVIATIONAL, TYPE=4)
C
  106     NTTMP=NTOF(NP)
          DO 112 NT=1,NTTMP
             LCTR=LCTR+1
             ISUB=LCTR
             ITYPE=NDV(NT+NROWI)
             WGHT=NWGT(NT+NROWI)
             IF (NC(NP).EQ.0) GO TO 111
             NCTMP=NC(NP)
             DO 110 NCI=1,NCTMP
                IF (ISUB.NE.NCON(NCI,NP)) GO TO 110
                IF (DIFF(NCI)) 107,108,109
  107           IF (ITYPE.NE.3) GO TO 110
                WOUT(ISUB,3)=-DIFF(NCI)
  108           GO TO 110
  109           IF (ITYPE.NE.4) GO TO 110
                WOUT(ISUB,4)=DIFF(NCI)
  110        CONTINUE
  111        TA(NP)=TA(NP)+WGHT*WOUT(ISUB,ITYPE)
  112     CONTINUE
          NROWI=NROWI+NC(NP)
C
C **** FILL IN THE OUTPUT VALUE FOR ATTAINMENT OF PRIORITY NP.
C
          WOUT(NP,1)=FIX(TA(NP))
  113 CONTINUE
C
C **** PRINT OPTIMAL SOLUTION
C
  114 WRITE (11,126)
      WRITE (11,127)
      DO 115 NV=1,NID
         IF(WOUT(NV,2).EQ.0) GO TO 115
         IF(NV.LE.NID) WRITE (11,7) NV,KID(NV),WOUT(NV,2)
         IF(NV.GT.NID) WRITE(11,128) NV,WOUT(NV,2)
  115 CONTINUE
 7    FORMAT(I3,3X,A24,3X,F15.4)
      WRITE (11,126)
      WRITE (11,129)
      DO 116 NP=2,NPRIT
         IF (NC(NP).EQ.0) GO TO 116
         NCTMP=NC(NP)
      DO 139 NCO=1,NCTMP
         N=NCON(NCO,NP)
         WRITE (11,130) NP,N,WOUT(N,3),WOUT(N,4)
  139 CONTINUE
  116 CONTINUE
      J=1
      IF(J.EQ.1) RETURN
      WRITE (11,126)
      WRITE (11,131)
      DO 117 NP=1,NPRIT
         WRITE (11,132) NP,WOUT(NP,1)
```

```
  117 CONTINUE
      WRITE (11,126)
      WRITE (11,133)
      WRITE (11,134)
      I=MAX0(NPRIT,NVAR,NROWI)
      DO 121 K=1,I
         IF (K.GT.NPRIT) GO TO 119
         IF (K.GT.NVAR) GO TO 118
         WRITE (11,135) K,(WOUT(K,J),J=1,4)
         GO TO 121
  118    WRITE (11,136) K,WOUT(K,1),(WOUT(K,J),J=3,4)
         GO TO 121
  119    IF (K.GT.NVAR) GO TO 120
         WRITE (11,137) K,(WOUT(K,J),J=2,4)
         GO TO 121
  120    WRITE (11,138) K,(WOUT(K,J),J=3,4)
  121 CONTINUE
      WRITE (11,126)
      RETURN
C
  122 FORMAT (1H1)
  123 FORMAT (/  39H  THE OPTIMIZATION ENDED ON SUBPROBLEM ,I5 /  13H  T
     1HERE WERE ,I5, 42H CONSTRAINTS IN THE FINAL OPTIMAL TABLEAU.)
  126 FORMAT (//80(1H*))
  127 FORMAT (1H0, 52HTHE OPTIMAL SOLUTION FOR THE DECISION VARIABLES X(
     1J))
  128 FORMAT (1H0,  2HX(,I3,  2H)=,F15.4)
  129 FORMAT (1H0, 25HTHE GOAL ACHIEVEMENTS ARE //   9H PRIORITY,2X, 11H
     1GOAL NUMBER,2X, 16HOVER-ACHIEVEMENT,2X, 17HUNDER-ACHIEVEMENT)
  130 FORMAT (4X,I2,10X,I2,10X,F10.4,10X,F10.4)
  131 FORMAT (1H0, 29HTHE PRIORITY ACHIEVEMENTS ARE //   9H PRIORITY,8X,
     1 11HACHIEVEMENT)
  132 FORMAT (4X,I2,10X,F10.4)
  133 FORMAT (1H0, 15H OUTPUT SUMMARY)
  134 FORMAT (1H0,  9HSUBSCRIPT,11X,  8H   A OPT,7X,  8H   X OPT,7X,  9H
     1  POS DEV,6X,  9H  NEG DEV /)
  135 FORMAT (I8,7X,4F15.4)
  136 FORMAT (I8,7X,F15.4,15X,2F15.4)
  137 FORMAT (I8,22X,3F15.4)
  138 FORMAT (I8,37X,2F15.4)
C
      END
```

David Oliver Tate was born on 12 August 1953 in Holyoke, Massachusetts. Being the son of an Air Force Officer, he traveled much of his life. After graduating from High School in 1971 he attended Millard School in Bandon Oregon. Then, in 1972, he entered the U.S. Air Force Academy and graduated in 1976 with a B.S. in Management. After completing Undergraduate Pilot Training in 1977, he was assigned to the 4th MAS as a C-141 pilot at McChord AFB, Washington. While at McChord, he served as a Squadron Safety Officer, Assistant Executive Officer to the Wing Commander, and Wing Staff Flight Examiner. He graduated from SOS as a Distinguished Graduate in 1983.

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